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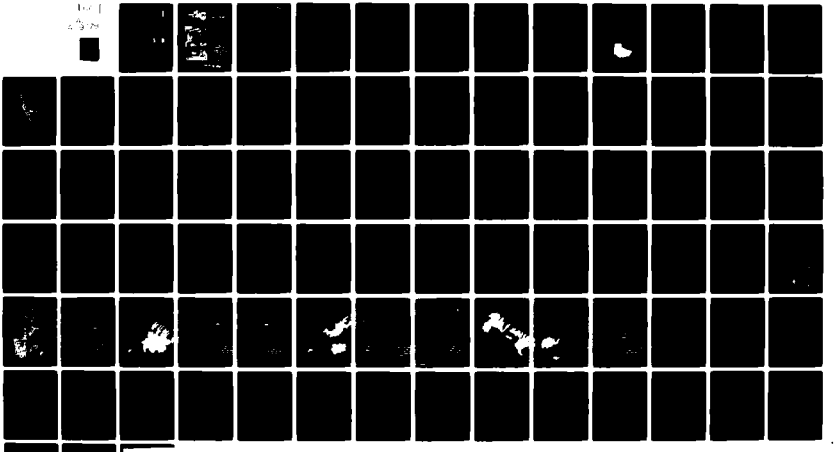

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STAGE 1 REPORT
ALTERNATIVES

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Environmental assessment
Upper Mississippi River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The study area includes the Yellow Bank, Lac qui Parle, Yellow Medicine, Redwood and Cottonwood Rivers drainage areas, all tributaries to the Minnesota River. This report is a review of problems and needs identification and focuses on alternative solutions. A primary feasibility report and environmental assessment will complete stage II. Problems include flooding, erosion and sedimentation, water quality, fish and wildlife habitat, and water use and supply.

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Alternatives are included for land treatment, channel alternatives, public purchase of floodplain lands, foodplain evacuation and enforcement, flood proofing, restoration of wetlands, and storage reservoirs.

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UPPER MINNESOTA RIVER SUBBASINS STUDY
(PUBLIC LAW 87-639)

ALTERNATIVES REPORT

GENERAL

The study area includes the Yellow Bank, Lac qui Parle, Yellow Medicine, Redwood and Cottonwood Rivers drainage areas. These rivers are principal tributaries for drainage from the southwest to the Minnesota River. All or part of nine counties in Minnesota and four counties in South Dakota are included in the study area.

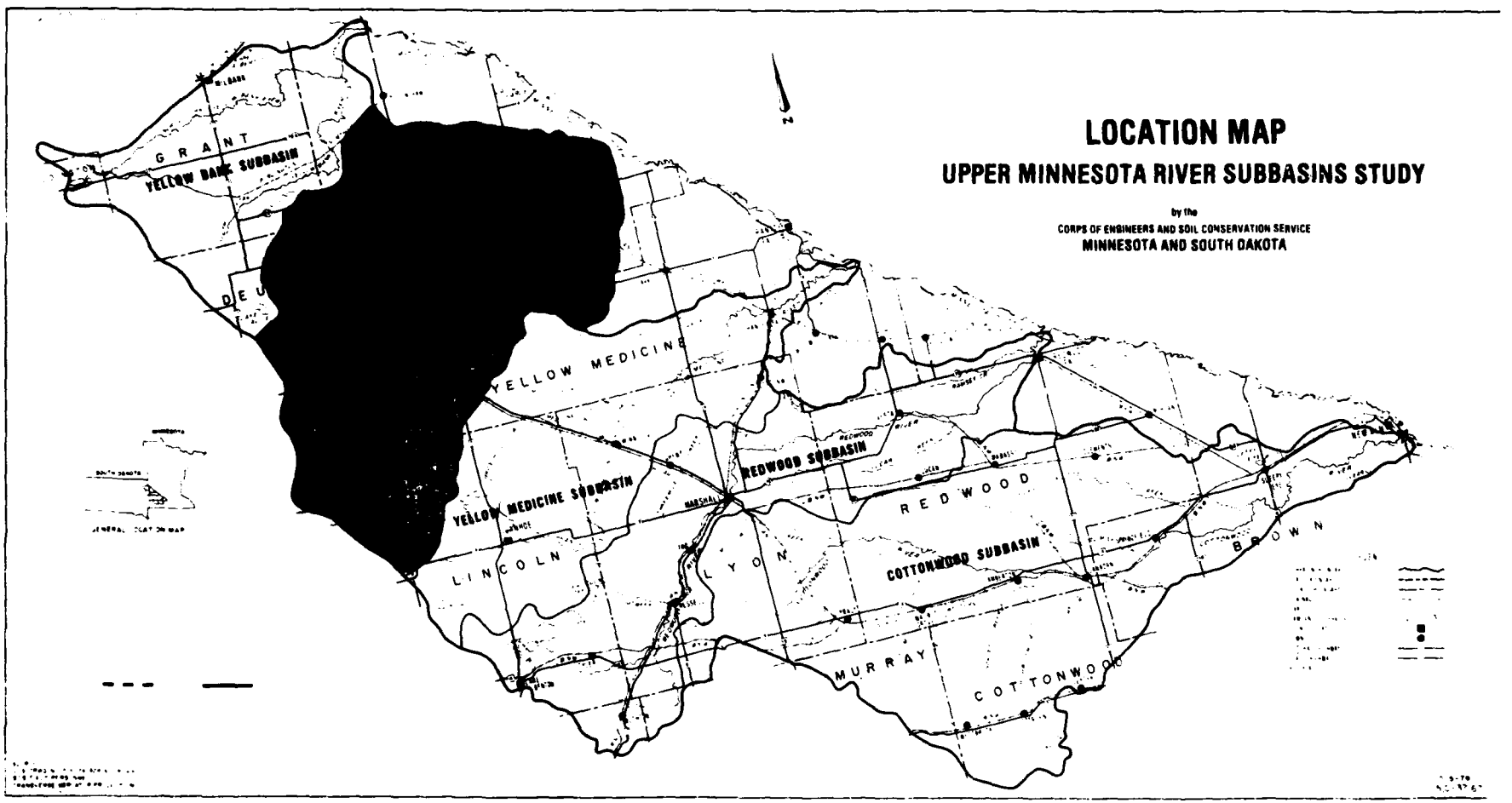
A unique geologic feature of the area is the Coteau des Prairies, which forms a plateau up to 1,000 feet higher than the region's lower plains. The five major streams originate in the hills of the Coteau, cross the lower plains, and outlet into the Minnesota River. The upper third of the study area lies above and along the steep slopes of the Coteau; the lower two thirds is a relatively flat area.

The study area covers 4,183 square miles (2,677,632 acres), which is 33 percent of the Minnesota River basin. The following figure shows the location of the study area.

AUTHORITY

The Governor of Minnesota asked Congress to authorize the Corps of Engineers (Corps) and the Soil Conservation Service (SCS) under Public Law 87-639 to conduct an implementation study for the area. The following resolution authorizing the study was passed by Congress in December 1975.

> "Resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that the Secretary of the Army and the Secretary of Agriculture are hereby authorized and directed to make joint investigations and surveys, as provided by Public Law 87-639, of the Redwood, Cottonwood, Yellow Medicine, Lac Qui Parle, and Yellow Bank Rivers' sub-basins of the Minnesota River Basin and to prepare joint reports on such investigations and


LOCATION MAP
UPPER MINNESOTA RIVER SUBBASINS STUDY
by the
CORPS OF ENGINEERS AND SOIL CONSERVATION SERVICE
MINNESOTA AND SOUTH DAKOTA
GRANT
YELLOW BANK SUBBASIN
YELLOW MEDICINE
YELLOW MEDICINE SUBBASIN
REDWOOD SUBBASIN
REDWOOD
COTTONWOOD SUBBASIN
LINCOLN
LYON
MURRAY
COTTONWOOD
BROWN

surveys setting forth their recommendations for the installation of works of improvement needed for flood prevention or the conservation, development, utilization and disposal of water, and for flood control and allied purposes. Such joint reports shall be prepared and submitted in compliance with the provisions of the public law cited herein."

INTERPRETATION OF THE AUTHORITY BY THE SCS & CORPS

The emphasis in studies of water and directly related land resources is on flood control within existing rules, regulations, and policies governing the work of each agency. The joint report to Congress shall include a water and related land resources plan recommended for implementation. Responsibility for implementation will be determined as part of the study process. The plan shall be accompanied by an environmental impact statement (EIS) and be in sufficient detail to permit its implementation. As mutually agreed by SCS and the Corps of Engineers, the report and EIS will be forwarded to Congress through appropriate channels after technical, public, and interagency review is completed in accordance with the Corps of Engineers policy concerning technical and public review. Implementation of the Federal elements of these plans is contingent on congressional action.

BACKGROUND

The Upper Mississippi River Comprehensive Basin Study, completed in 1972, recommended further study of water quality, flood and sediment damage, water supply, commercial navigation, recreation opportunity, and environmental preservation in the Minnesota River basin. In 1971, the Southern Minnesota Rivers Basin Board (SMRBB) was formed to coordinate further resource planning in the basin. The Board in cooperation with the SCS responded to the above recommendation by conducting a river basin Type IV study under the authority of section 6 of Public Law 83-566. The Minnesota River Basin Study Report, published in 1977, includes a recommendation for joint study by the Corps and SCS under the authority of Public Law 87-639.

REPORTS

A Reconnaissance Stage Report (plan of study) completed in September 1978 was the first report of the joint study. The report presents resources, problems, suggested solutions, and schedule and cost estimates for this level C implementation study. The plan of study describes the planning process for the study consistent with the planning requirements of the Water Resource Council's Principles and Standards and SCS-Corps policies and regulations.

This report is a review of problems and needs identification and focuse on alternative solutions. These planning steps were done in a preliminary manner in the type IV study for the Minnesota River basin.

The intent of this report is to focus on the study of alternative measures which address solutions to the problems and needs. This study of alternatives seeks to verify and expand the earlier information on problems and needs and the effectiveness of each alternative in solving the problem or meeting the need. This information must be developed in sufficient detail to understand the advantages and disadvantages of each alternative. The alternatives are evaluated or screened on the basis of how well they meet the planning objectives.

The level of detail used to evaluate alternatives in this stage is based on preliminary economic, environmental, social, and regional information. Alternatives which have sufficient merit after review and screening in the preliminary information stage are carried forward. The most desirable alternatives will be combined into plans. A preliminary feasibility report and environmental assessment will complete stage II.

This report presents the available gross appraisal data for each alternative identified during the public involvement program in fiscal year 1979. The effectiveness of each alternative in achieving flood damage reduction or other planning objectives and the impacts caused by its implementation determine its merit for either being carried forward into the intermediate plan stage or being dropped from further consideration. This screening of

alternatives is the basis for refining the study work schedule, cost estimate, and manpower requirements shown in the plan of study. This report concludes stage I of the study.

PROBLEMS, NEEDS, AND ALTERNATIVES

A citizens participation committee conducted a public workshop on 1 March 1979 to identify and rank problems and needs and alternative measures to solve the problems and meet the needs. The committee met on 26 April 1979 to screen the 22 problems and needs and 22 alternatives from the March meeting for practicability and acceptability. The following remaining 9 problems and needs and 14 alternatives resulted from the screening. For details of the identification, ranking, and screening, see the public involvement appendix.

Flooding[1]

Flooding is identified as the major problem in the study area. Unique to the area is "crossover flooding." Because of the flatness of the lower plains, floodwaters from one watershed often cross over into neighboring watersheds. Under future without project conditions, total average annual damages are about $13.4 million. More than 200,000 acres, mostly farmland, are subject to flooding. The following figure shows major flood damage areas.

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(1) Flooded area and damages for land use and type damage categories for each subbasin are presented on page 35, Plan of Study (POS), September 1978.

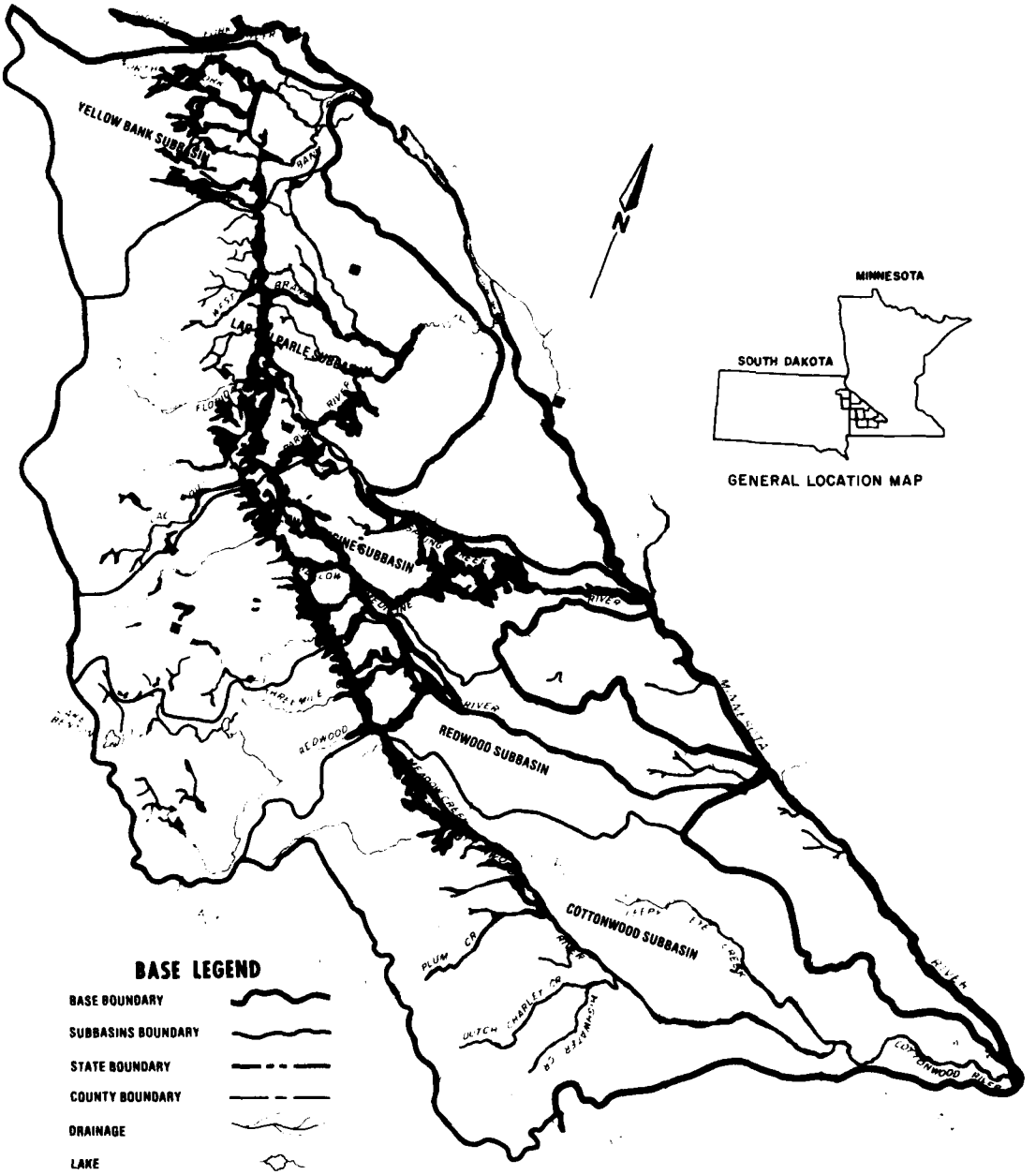
MAJOR FLOOD DAMAGE AREAS

UPPER MINNESOTA RIVER SUBBASINS STUDY

by the

CORPS OF ENGINEERS AND THE SOIL CONSERVATION SERVICE

MINNESOTA AND SOUTH DAKOTA



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SCS DRWG. NO. S,S-34,384(6-78) AND
SCS FIELD PERSONNEL
TRANSVERSE MERCATOR PROJECTION

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Erosion and Sedimentation[2]

Sheet and rill erosion caused by wind and/or water runoff is a serious problem on nearly 42 percent of all agricultural land in the study area. About one-third of the cropland with an e' sion hazard is adequately treated. Soil loss on the remaining hazard cropland exceeds the tolerable level of 4 tons per acre per year. Sedimentation is a problem wherever the soils are deposited.

Need to Improve Water Quality[3]

Water pollution in surface waters of the study area is a moderate to severe problem. The major source of high nutrient levels is overland runoff across erodible soils. Of particular concern are fishing lakes. The Minnesota Pollution Control Agency found that pollution potential from livestock feedlot operations in the study area is high.

Inadequate Fish and Wildlife Habitat[4]

Loss of habitat to land use change and deteriorating quality of remaining habitat is a serious problem for wildlife values in the study area. Fishing waters are subject to the problems noted above in water quality. The general categories of sedimentation, rough fish invasion, and acceler - ated eutrophication problems are caused by overland flooding and resulting erosion of soil particles which contain pesticides and nutrients. The erosion of streambank and shoreline vegetation and deposition of sediment on the floodplain and in streams and water bodies further reduce habitat values.

Excess Water on Agricultural Land[5]

Excess water is the dominant problem on about 1,844,300 acres or over 70 percent of agricultural land in the study area. The actual drainage need depends on the desired use and potential economic return of the land to the owner.

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(2) Soil treatment and loss on agricultural lands, table on page 43, POS. Sediment source areas map, page 48, POS.
(3) Improvements needed in fishing lakes, 1972, table on page 58, POS.
(4) Fish and wildlife problems in the study area, pages 61-69, POS.
(5) Drainage needs, figure, page 40, POS.

Need for Additional Recreation Opportunities[6]

Existing water and land recreation facilities are deficient in meeting the demand both in number and distribution within the study area.

Water Supply Need[7]

There is no existing municipal water shortage. There is a projected need for 140,000 acre-feet of water for irrigation by 2020. The U.S. Geological Survey is conducting groundwater studies to determine irrigation potential in the study area. The conservation of water will be a first consideration in developing measures to alleviate future water supply problems.

Need to Develop Hydroelectric Power[8]

Hydroelectric power is a nationwide need recently investigated by the Corps and Hydrologic Engineering Center, Davis, California. In this report, the only potential for hydroelectric power production in the study area is on the Cottonwood River at New Ulm, Minnesota. The potential is defined as 6,500 kilowatts capacity and 15,200 megawatt-hours average annual energy output.

---

(6) Demand by projected visits, facilities needed and priorities for development shown on tables, pages 71-72, POS.

(7) Groundwater distribution in the study area is shown on the figure, page 77, POS.

(8) "Preliminary Inventory of Hydropower Resources, National Hydroelectric Power Resources Study," Lake Central Region, Volume 4, July 1979.

PROBLEMS & NEEDS / ALTERNATIVES	FLOODWATER STORAGE RESERVOIRS	LAND TREATMENT	CHANNEL WORK	SNAGGING & CLEARING OF CHANNELS	FLOODPLAIN ZONING & ENFORCEMENT	CROSSOVER LEVEES	RESTORATION OF WETLANDS	LEVEED FLOODWAYS FOR CROSSOVER FLOODING	PUBLIC PURCHASE OF FLOODPLAIN LANDS	CHANNEL CUTOFFS FOR FLOOD FLOWS	ENVIRONMENTAL CORRIDORS	FLOOD PROOFING	FLOODPLAIN EVACUATION (2-YEAR OR ECONOMIC OPTIMUM FLOODPLAIN)	NO ACTION
FLOOD DAMAGE	+	+	+	+	+	+	+	+	+	+	+	+	+	0
EROSION & SEDIMENTATION	+	+	+	+	+	+	+	+	+	+	+	0	+	0
WATER POLLUTION	+/-	+	+/-	+/-	+	+	+	+	+	+	+	+	+	0
LOSS OF FISH & WILDLIFE HABITAT	+/-	+	-	-	+	-	+	+/-	+	+/-	+	0	+	0
INSUFFICIENT DRAINAGE ON AGRICULTURAL LAND	+	+	+	+	+/-	+	-	+	0	+	-	0	0	0
SHORTAGE OF RECREATION OPPORTUNITIES	+	+	-	+/-	+	0	+	+	+	+	+	0	+	0
PROJECTED NEED FOR ADDITIONAL WATER SUPPLY	+	+	-	0	0	0	+	0	0	0	0	0	0	0
CONSERVATION OF WATER FOR FUTURE USE	+	+	-	0	0	0	+	0	0	0	0	0	0	0
POTENTIAL FOR SUPPLYING HYDROELECTRIC POWER	+	0	0	0	0	0	-	0	0	0	0	0	0	0

PLANNING OBJECTIVES

The identified planning objectives for the study are:

1. Contribute to the maintenance and improvement of agricultural land by management of water flow within and between each of the five subbasins.

2. Contribute to the maintenance or improvement of the soil resource base by reducing erosion.

3. Contribute to the improvement of water quality by reducing the levels of nutrients, sediments and other pollutants in surface runoff waters.

4. Contribute to the maintenance and improvement of fish and wildlife habitat in the study area.

5. Contribute to the efficient use and management of surface and subsurface water for improved yields on wet agricultural soils.

6. Contribute to the improvement of opportunities for outdoor recreation.

7. Contribute to the conservation and management of water resources to insure adequate present and future supplies.

8. Contribute to the maintenance and improvement of cultural and social resources.

STUDY

General

The Corps and SCS are primarily responsible for the investigation, surveys, and reports on problems and recommended solutions for the study area.

Flooding was identified as the major problem in the study area. All of the above alternatives will address flood damage reduction. During spring thaw and heavy rains, normally dry channels overflow, spilling water down the slopes of the Coteau onto the lower plain. The drainage system in the lower plain is poorly developed. Many existing channels, clogged with sediments and debris, are incapable of handling the heavy and sudden flows of water. Crossover flooding complicates flood control efforts. Runoff from the higher area must be controlled to protect the lower plains from resultant flooding, erosion, and pollution.

The major work effort for 1979 was evaluation and screening of the reservoir alternative using hydrology-hydraulic and economic data available in the SCS TR-20 model. Similar data were not available to evaluate other alternatives to the same level of detail. The data will be determined in stage II studies described in paragraph "General" under the following section "Studies for Channel Alternatives."

The total 1979 study effort was performed by a study team made up of eight major work groups - public involvement, planning and study management, hydrology and hydraulics, engineering, erosion and sedimentation, economics, environmental, and water quality. A team effort produced this report. The major work items and general conclusions of the work are shown for each work group.

Public Involvement

The SCS-Corps study chairmen, with representatives of the Southern Minnesota Rivers Basin Board, State of Minnesota Water Planning Board, and Department of Natural Resources, developed the public involvement program. A new public group, the citizens participation committee, was formed in January 1979. Its membership, by-laws, and minutes of meetings for the year are shown in the public involvement appendix. The highlights of the meetings were the identification of problems and needs, suggestion of possible alternative solutions, and screening of alternatives for acceptability and practicability. Public involvement in 1980 will included contact with the landowners who are directly affected by a proposed alternative solution

or whose property is in the 639 flooded area. This contact will be made through small meetings with affected parties.

The following contacts were the other significant public involvement efforts during fiscal years 1979 and 1980:

October 1978. SCS-Corps study cochairmen discussed the plan of study at the Minnesota Valley Conference at Mankato, Minnesota.

May-September 1979. Governors of Minnesota and South Dakota were requested to state their concerns about the suggested alternative solutions and their willingness to participate in a flood management program requiring monetary commitment by the States. Their responses are shown in the public involvement appendix.

June 1979. SCS-Corps published a 639 study brochure.

August 1979. SCS-Corps study cochairmen reported on the status of the study to the South Dakota Natural Resources Cabinet Subgroup at Pierre, South Dakota.

September 1979. SCS-Corps study cochairmen reported on the status of the study to the Area II Minnesota River Basin Projects, Inc., at Marshall, Minnesota.

October 1978-September 1979. The Southern Minnesota Rivers Basin Board continued overall guidance of the study. Status reports were presented at monthly meetings by representatives of the SCS-Corps.

November 1979. The public involvement work group met on 20 November 1979 to update the public involvement plan, review the membership and functions of the public involvement work group, and determine the future role and membership of the citizens participation committee. See public involvement appendix.

Further public involvement in stage II planning will be similar to the above activities, with increasing contact with affected landowners as alternatives are screened for further study. The public involvement will be more specific with respect to affected citizens and areas in stage III planning. A general coverage of public involvement required by principles and standards and other planning regulations is shown on the revised study schedule in the appendix.

Planning and Study Management

Study progress was monitored this year through periodic meetings which became weekly during the last 3 months. The early meetings concentrated on policy, procedures, depth of investigations, evaluations, and display of findings. The later, more frequent meetings were evaluations of the reser - voir and some channel alternatives' economic, environmental, social, and regional development impacts. These two alternatives were addressed within the limitations of available information. The work group concept proved effective in communication and work production.

The general duties and procedures of this work group in formulating a final comprehensive flood management plan for the 639 area are described in the plan of study. A revised schedule of planning and study management tasks for stages II and III of the study is shown in the appendix.

Hydrology and Hydraulics

The Hydrology and Hydraulics Work Group has been involved in collecting the following data and performing the following tasks since the initiation of the study:

1. Maps: a. Aerial photography (1978 and 1979) has been obtained for all upland areas and all major floodplains of the five subbasins. The photography is suitable for preparing topographic maps with a 4-foot primary contour interval and 2-foot interpolated contours at a scale of 200 feet per inch. Detailed topographic maps have been completed for the major floodplains of the Yellow Bank subbasin and are nearly complete for the Lac qui Parle subbasin.
   b. Aerial photos (1977) at a scale of 1 inch = 2,000 feet have been obtained for the Minnesota portion of the subbasins. Individual photos (termed quad centered photos) cover the same area as U.S. Geological Survey 7 1/2 minute quadrangles.
   c. A family of maps system has been established for each subbasin. These maps are compiled at a scale of 2 miles per inch for ulti - mate reproduction at report size at 4 miles per inch. These maps can be used to display the components of alternative plans.

2. Surveys: a. Channel and bridge surveys have been completed for the North and South Forks of the Yellow Bank River and two major tributaries. Color photos were taken looking upstream and downstream from each cross section and bridge. Channel and bridge surveys are available for the main stem of the Lac qui Parle River from the mouth upstream to State Highway 68 and on the West Branch of the Lac qui Parle River upstream to U.S. Highway 212 near the mouth of Florida Creek. Channel and bridge surveys are available for the Yellow Medicine River including the north and south branches up to State Highway 68. The surveys of the Lac qui Parle and Yellow Medicine Rivers were obtained by the Corps of Engineers in 1965 and 1966 and will have to be updated and supplemented in some reaches.
b. In the process of developing the detailed topographic maps of the floodplains, an intensive system of horizontal and vertical control has been established. Bench marks are available no farther than 1 mile from any floodplain area that has been mapped.

3. General: The watersheds established in the SCS Conservation Needs Inventory (CNI) in 1967 have been delineated and measured on U.S. Geological Survey maps. These delineations and measurements are of sufficient accuracy for final hydrologic modeling of the subbasins although they require further subdivision.

4. Alternative Component Studies: a. Hydraulic design of floodwater retarding structures. - Preliminary hydraulic design has been completed for 48 floodwater retarding structures with drainage areas under 20 square miles and 18 structures with drainage areas over 20 square miles. Preliminary hydraulic design of structures includes the determination of spillway elevations and dimensions, the corresponding reservoir sizes, and the top of dam elevations. These data were used to evaluate environmental impacts in reservoir areas and to determine land rights and structure costs.
b. Channel studies. - No new studies have been performed to determine the reduction of flood damages through channel work. Studies

performed by the Corps of Engineers in 1967 in certain reaches of the Lac qui Parle and Yellow Medicine Rivers have been updated to reflect 1979 costs and benefits. Channel work data are presented for these reaches merely because the data are available - not because these reaches necessarily are the most in need of channel work in the five subbasins.

c. Evaluation of discharge-frequency-area flooded. - The SCS TR-20 hydrologic model used in the USDA Type 4 Study has been refined and used to estimate discharge-frequency relationships throughout the five subbasins. The discharge-frequency has been further correlated with stream gage data. Discharge-frequency was related to area flooded-frequency for present conditions through studies of historical floods and from interviews with local people. The area flooded-frequency relationships established in the USDA Type 4 Study were used with revisions in some reaches. Average annual area flooded for present conditions was calculated from the area flooded-frequency relationships.

To date the floodwater retarding structure alternative is the only alternative that has been evaluated using the hydrologic model. The model was run with all 64 structures in place and assuming no crossover flow between subbasins. At many crossover points, levees are necessary to prevent crossover flooding with the floodwater retarding structures in place.

The discharge-frequency and corresponding average annual area flooded with the 64 retarding structures in place was determined. The reduction in flooding due to an individual structure was based on the ratio of the drainage area controlled by the structure to the drainage area controlled by all structures above the major damage reaches. Evaluations were made in 154 damage reaches located primarily on the major floodplains. Generally, benefits were not evaluated in the reaches immediately below structures because of lack of area flooded data. More detailed methodology for the 1979 work and a schedule for stages II and III of the study are shown in appendixes A and B, respectively.

Engineering

A profile was obtained along the center line of each of the proposed damsites from U.S. Geological Survey quadrangle sheets. Since there is no topographic mapping in this area, the ground surface was assumed to be level for estimating quantities.

The locations of the spillway and low-flow conduit were not specifically placed at this time; however, the amount of borrow material was approximated by the general configuration of the damsite.

The above assumptions were used to calculate quantities which were then multiplied by current unit prices to obtain an approximate cost estimate.

More detailed methodology for the 1979 work and a schedule for stages II and III of the study are shown in appendixes A and B, respectively.

Erosion and Sedimentation

The efforts of the Erosion and Sedimentation Work Group were largely directed toward initial land use and protection determinations for the entire study area. General land use, soils capability information, land protection status, and soil erosion data were formulated based on data available from the Southern Minnesota River Basin Type IV Study, Resource Conservation Act efforts, and information generated for water quality planning under Section 208 of Public Law 92-500. These data were compiled for the entire study area and do not address the individual subbasins.

In addition to the determination of present land quantity/quality level(s), land protection was projected to 70 percent and 80 percent on all land uses to illustrate reduced erosion and the additional installation and technical assistance costs for an accelerated program. A third protection alternative was developed to illustrate 70 percent protection on only the acreage of watershed area above all potential reservoir sites. This projection was based on low frequency sampling data collected by district conservationists and intended for sediment studies.

Throughout this phase, close communications have been maintained with area and field personnel in Minnesota and South Dakota. Meetings, including one in Marshall, have been conducted to permit work group concurrence in data formulated.

Specific site information collected in the field has been analyzed to determine the general land use within individual watershed of potential reservoir sites. Potential land protection needs by land use in acres have been estimated for individual watersheds based on the average present protection levels for the entire study area.

Future efforts of the work group will be toward specific determinations based on higher frequency sampling to obtain more refined data. Districts within the study area have been placed on priority for Inventory and Monitoring (IM) and output of the IM Program will be used in future determinations. More detailed methodology for the 1979 work and a schedule for stages II and III of the study are shown in appendixes A and B, respectively.

Economics

The basis for the economic analysis for the Alternatives Report was the economic data developed for the Type 4 Study (Minnesota River Basin Study). The information in the Type 4 study was updated using the Water Resources Council's current normalized prices and land use figures developed from farm interviews.

Farm interviews were conducted on 10 percent of the floodplain farms. The farms were chosen by district conservationists after they were notified of the specific floodplains from which to select these farms. The information requested from the farmers is outlined on the interview form and the supplemental question sheet attached (attachments 1 and 2). The interview data were used to help develop dollar damages per acre from cropland, pasture, erosion, and other agricultural damages.

Additional Questions
639 Agricultural Interviews
December 1978

1. Outline 1969 and 1978 flood, or whatever largest flood was.

2. What years do you recall flooding? Reference to peaks.

3. Is problem overbank flow or drainage-bank full?

   If Drainage: a. Outlets needed.
   b. Type, tile or surface.
   c. What is the effect?

4. What is your absolutely last planting date for each crop and to expect an adequate yield? When are crops in?

5. Will you plant later than this date to qualify for crop insurance?

6. Yields on floodplain for last five years, by year.

SCS-WS-1
JUNE 1972
FILE CODE WS-16

FLOOD DAMAGE – AGRICULTURE

FORM APPROVED
OMB NO. 40-R3809
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Respondent _____ Years on Farm _____ Farm Location _____ Watershed _____ Reach _____

Flood Date _____ (Mo.) (Yr.) No. of Acres Flooded _____ How frequently do floods of this size occur _____ No. of Acres Flooded by largest flood _____

Damage to Crops and Pasture From Flood of Above Date

Land Use	No. of Acres	Depth of Flood (Ft.)	Duration of Flood (Hrs.)	Expected Yield/Acre If No Flood	Yield/Acre After Flood	Alternate Crop & Yield/Acre	Additional Production Practices Performed Due to Flood	Production Practices Not Performed Due to Flood

REMARKS

Other Agricultural Property Damage From Flood of Above Date

Item	Type	Quantity	Depth of Flood	Estimated Damage (Dollars)

Estimated Land Damage From Flood of Above Date

Kinds	Acres	Productivity Loss	Remarks

Date of Interview _____

By _____

19

Attachment 2

LAND USE IN TOTAL FLOODPLAIN

Crop	No. of Acres	Usual Date for Production Practices				Date too late to *Plant*
		Land Preparation	Planting	Cultivating	Harvest	

1. What changes in land use have you made due to floods? _____
2. What changes would you make if the frequency of flooding were reduced by half? _____
3. How often do large floods occur? (If the flood described above is a large flood, change this question to small floods.) _____
4. During what seasons are floods most common? _____
5. In addition to the loss in yield described above, was there any damage to quality of crops? _____
6. What damage did this flood do to roads and bridges nearby? _____

Use other side for REMARKS.

The study area was divided into 153 evaluation reaches. Crop and pasture damages, transportation damages, erosion damages, other agricultural damages, and indirect damages were computed by reaches. The differences in acres flooded for future with and without project conditions were used to compute benefits for the above categories. All benefits were computed by evaluation reaches. Benefits in each reach were then allocated to each structure based on the drainage area controlled by the structure if it had an effect on reducing flooding in a given reach.

A 5-year frequency protection in all agricultural damage reaches with retarding structures in place was assumed to provide the maximum benefit that can be achieved. The maximum obtainable benefit was deemed appropriate for the initial screening process.

Construction costs for structural measures were amortized at 6 7/8 percent for 100 years. This amortized cost was compared to benefits allocated to each structure. Each structure was then rated from -3 to +3 depending on the benefit-cost ratio. Ratings of + begin at a benefit-cost ratio of 0.8.

More detailed methodology for the 1979 work and a schedule for stages II and III of the study are shown in appendixes A and B, respectively.

Environmental

Biological Resources Subgroup studies to date have produced several products for present and future use. The Minnesota Department of Natural Resources representative provided county maps and a summary report on the fish and wildlife resources in the study area. Included are locations of wetlands by type, streams by classification, State owned land by purpose, trout streams, colonial water bird nesting sites, and deer wintering areas. Stream fishery survey data and wildlife census data were also included. Locations of Federal waterfowl production areas and refuge land, South Dakota game production and public shooting areas, Nature Conservancy tracts, and additonal wetland inventory data were provided by the U.S. Fish and Wildlife Service and the South Dakota Department of Game, Fish and Parks. All data have been placed on the county maps by color code for present and future use.

During a 4-week field tour, the subgroup visited each reservoir site in the study area and all proposed channel reaches. Notes were recorded on the various habitat types, dominant vegetation, and habitat quality of the land and water uses within the proposed reservoir pools and at road crossings along the channel reaches. Pictures and slides were taken at each location for future reference. In conjunction with the Inventory and Monitoring (IM) Program of the Soil Conservation Service, the Biology Subgroup initiated the collection of additional vegetative and wildlife habitat data at each random sample point visited for the IM Survey in the study area. When the data collection is completed in 1981, this information will provide basin-wide habitat quantity and quality data with a sampling intensity of between 7 and 11 percent per county.

Evaluation of biological impacts from implementing various alternatives was based on the above study products. These evaluations are preliminary and subject to change when more detailed studies are completed during the remainder of the study. Certain habitat types or land uses were determined to be in critically short supply or are experiencing accelerated conversion to more intensive use. The quantity and quality of these affected habitat types further defined the severity of potential impacts: woodland, especially riparian woodlands identified as deer wintering areas; wetland types 3, 4, 5, and 6; stream fisheries, especially trout streams; State and Federal Management and refuge lands; and native prairies (more critical in Minnesota). Each site was evaluated for biological benefits which might be created by the alternative and then compared to the losses of present resources at the site. For reservoirs, ratings of +1, +2, or +3 could result from cropland or heavily grazed pasture being converted to quality wetlands with specially designed sediment pools in the reservoir. Pools which are shallow, broad, and flat would provide the greatest number of acres of quality wetlands and thus received the highest positive ratings. Conversely, ratings of -1, -2, or -3 could result when the pool characteristics would not create quality wetlands or reservoir fisheries, and the reservoir would destroy woodlands, wetlands, stream fisheries, State and Federal lands, or native prairies. A rating of -3 was assigned when several high quality or critical habitats would be lost and those losses would be nearly unmitigable. The (-3) ratings should be viewed as a screening tool used to identify sites which

would cause major adverse impacts and should be avoided entirely, if possible. In the next planning stage, evaluation of other alternatives, both structural and nonstructural, will be made when engineering, hydrologic, economic, and more detailed environmental studies are available.

The Recreation Subgroup task during this phase of the study was to provide a preliminary evaluation of the impacts on recreation opportunities at each of the potential reservoir sites and channel modification reaches. To accomplish this task, group members reviewed all available regional and State recreation plans to obtain an overview of the existing and planned recreation opportunities within the study area. Specific site/reach information was obtained from field surveys conducted by personnel from the South Dakota Department of Game, Fish and Parks; the Minnesota Department of Natural Resources; the U.S. Fish and Wildlife Service; the Corps of Engineers; and the Soil Conservation Service. The evaluations were based on the information obtained and professional judgment.

The evaluation consisted of answering three basic questions:

1. Does the project offer any reasonably exploitable recreation opportunities?
2. If opportunities are created, what is their magnitude, accessibility, etc.?
3. Would the project destroy existing recreation opportunities/resources?

The answers to these questions are to be based, in part, on existing land use, potential recreation uses without a project, potential pool size in terms of surface acres and depths, potential recreation uses with the project, and potential water quality. Comparisons were made between existing and possible future conditions and the existing and future recreation needs of the area.

During this phase of the study, no attempt was made to estimate visitation or recreation benefits associated with any alternative. During future planning phases, as more detailed information becomes available, these data can be developed.

The work tasks associated with stage II of this study are to: evaluate additional alternatives (to the same degree as those in the report); further evaluate alternatives which pass the initial screening; and begin to quantify the gains and/or losses in recreation associated with a given alternative.

The Social Subgroup evaluation will ultimately require consideration of the impacts on at least the following elements of social life: noise; population mobility, density and displacement; aesthetics; housing; transportation; education, cultural, and leisure opportunities; community cohesion; desirable community growth; institutional relationships; and health. None of these elements can be studied in depth at the present stage of this study, but effects were analyzed when they were both (a) able to be estimated and (b) considered possibly relevant to the alternative under consideration[1]. For 46 reservoir sites, effects were directly or indirectly quantified for noise, population displacement, transportation, leisure and cultural opportunities, and community cohesion. Due to data limitations, these impacts were analyzed only for the reservoir sites rather than for the downstream reaches. Consequently, the social effects related to the reservoir alternative are mostly negative. That is, benefits from this flood control measure will accrue to people below the structures (in health and economic security, as the most obvious effects), while people close to the sites will experience the burden of relocation, interruption of their livelihood, disruption of community life, construction noise, and a sense of lost control in local political processes. Occasionally, a site will provide benefits to owners (wishing to sell land or change land use) or to immediate neighbors (desiring a recreation reservoir pool). Further study will be required to determine the extent and location of effects in the site area. Further hydrologic studies are needed before benefits to downstream areas can be determined.

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(1) The only alternative so analyzed in this stage of the study was reservoir storage of floodwaters for specific proposed sites. This alternative must also be analyzed in terms of the effects of a subbasin or basin system of reservoirs. Such a system may have more and different impacts than the simple total of the individual sites.

Social impacts for other alternatives must also be analyzed in the next stage of the study. The impacts of some alternatives, such as evacuation of the 2-year floodplain (that is, changing its land use patterns to uses more compatible with periodic flooding), may be found to more equitably distribute costs and benefits, but perhaps be more politically controversial. Others, such as channelization of streams, may arouse less controversy within the subbasins, yet be more inequitable in their effects.

We currently lack data on the impact of nonstructural alternatives, and our information on the reservoir alternative is incomplete. In the next planning stage, an institutional analysis, a social profile, and descriptive and attitudinal surveys are planned to gain an understanding of the social impacts of these alternatives and the public's response to them.

The Cultural Resources Subgroup consulted the listings of officially recorded sites maintained by the Minnesota State Historic Preservation Office for its preliminary evaluation of the reservoirs and reaches of channel works under study. Site information was provided by the South Dakota State Historic Preservation Office, although the legal locations were not detailed enough to locate sites in relation to the alternatives. Landowners have also reported sites in several pool areas which were included in this evaluation. This is considered a minimal review, as other maps, records, and files maintained by the State Historical Societies and State Archeologist's offices will greatly increase the number of sites and leads that have never been verified or assigned site numbers.

The aerial photographs and data inventory sheets were evaluated considering the proximity to known sites, confluences of tributaries, topography and, to some extent, disturbance. Potential historic/architectural properties such as farmsteads were not considered in this review. A rating of -3 indicates there has been a site recorded or reported within or close to the area of that alternative. A rating of 0 does not imply that a field survey is not necessary but rather that it appears less likely that sites will be discovered. This initial screening is primarily to identify alternative sites where there are indications of potential problems with a location. A statistically valid sample survey would be required to make more accurate predic-

tions regarding cultural patterns that may occur within the alternative areas.

A record and literature review of the study area will be completed to identify known sites and site leads. Reconnaissance and intensive surveys of potential impact areas will be conducted in subsequent planning stages.

More detailed methodology for the environmental work group 1979 work and a schedule for stages II and III of the study are shown in appendixes A and B, respectively.

Water Quality

The preimpoundment water quality study of the proposed reservoirs was begun in 1979 with the development of a preliminary plan of study and scope of work and completion of a field reconnaissance survey. The water quality study is described in appendix B. The reconnaissance survey, conducted during June 1979, provided water quality data, stream discharge measurements, and other pertinent information needed in selecting suitable sites for the detailed studies scheduled for fiscal years 1981 through 1984. During the reconnaissance survey, 72 proposed damsites and 24 existing reservoirs were visited. The water quality monitoring and analysis will be accomplished by the U.S. Geological Survey under a support agreement with the Corps of Engineers.

Of the 24 existing reservoirs visited, the 10 best suited to the purposes of the study were selected based on age, morphometry, watershed characteristics, geographic location, and accessibility. The surface areas of these reservoirs range from 5 to 22 acres. Maximum depths range from 12 to 24 feet. Many of the reservoirs having depths greater than 15 feet displayed considerable thermal and dissolved oxygen stratification. Water transparency (secchi disc) ranged from very clear (less than 10 feet) to moderately turbid (1.5 to 3 feet) during the low-flow period to very turbid (less than 1 foot) following rainfall runoff. Several of the reservoirs have been stocked with game fish, and satisfactory results were reported by local users.

The process of selecting study sites from among the proposed damsites is currently in progress. A meeting will be arranged in 1980 to consult with the participating Federal and State agencies to discuss the program before making the final monitoring sites selections.

SUMMARY OF ACCEPTABILITY OF ALTERNATIVES

Acceptability is a measure of an alternative's acceptance by the public and compatibility within known institutional constraints. It defines the workability and viability of the alternative. The following ratings are expressions of concerns from the respective groups or agencies about the impacts of the alternatives. The concerns were expressed during workshops and in comment/response to letters.

Implementability is a measure of an alternative's potential to be transformed from concept to reality. This screening eliminates alternatives which are not institutionally and technologically feasible, lack public support, or do not address the planning objectives. The following ratings by the SCS, Corps, and local implementing authorities are their expressions of capability, including legal status and overall willingness to help implement the alternatives.

Summary of Alternatives Acceptability and Implementability[1]

Alternative	ACCEPTABILITY[1]					IMPLEMENTABILITY			Comments/Status
	Citizens Participation Committee	SMRBB	MN	SD	USFWS	Local	SCS-Corps	Keep or Drop	
Floodwater storage reservoirs	Yes	Yes	(2)	(2)	(2)	Yes	Yes	Keep	Screening of reservoir feasibility by SCS-Corps, Minnesota, and South Dakota is shown in following section.
Land treatment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Keep	This alternative will be evaluated individually in further detailed studies.
Channel work	Yes	Yes	(2)	(2)	(2)	Yes	Yes	Keep	Screening of channel work is only by Corps for downstream Lac qui Parle and Yellow Medicine Rivers using existing data. Further evaluation will be done in detailed studies.
Snagging and clearing of channels	Yes	Yes	(2)	(2)	(2)	Yes	Yes	Keep	Existing hydrologic/economic data are not sufficient to adequately evaluate and screen clearing and snagging as a single alternative. Further study is needed.
Floodplain zoning/enforcement	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Keep	The study envisions an overall flood management program for the 639 area which would include floodplain zoning, enforcement, and flood insurance.
Crossover levees	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Keep	Existing hydrologic/economic data are not sufficient to evaluate crossover levees as a single alternative. It will be studied further.
Restoration of wetlands	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Keep	Existing hydrologic/economic and location data are not sufficient to evaluate restoration of wetlands. It will be further studied with USFWS, MN and SD.
Leveed floodways for crossover flooding	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Keep	Existing hydrologic/economic data are not sufficient to adequately evaluate and screen as a single alternative. It will be studied further.
Public purchase of floodplain lands	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Keep	Existing hydrologic/economic data are not sufficient to define and evaluate this alternative individually. It will be studied further.
Channel cutoffs	Yes	Yes	(2)	(2)	(2)	Yes	Yes	Keep	Existing hydrologic/economic data are not sufficient to evaluate alternative. Study further.
Environmental corridors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Keep	Existing hydrologic/economic data are not sufficient to evaluate the alternative. Study further.

Alternative	ACCEPTABILITY[1] Citizens Participation Committee	SMRBB	MN	SD	USFWS	IMPLEMENTABILITY Local	SCS-Corps	Keep or Drop	Comments/Status
Flood proofing	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Keep	Existing hydrologic/economic data are not sufficient to evaluate the alternative. Study further.
Floodplain evacuation (2-year or economic optimum floodplain)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Keep	Existing hydrologic/economic data are not sufficient to evaluate the alternative. Study further.
No action	-	-	-	-	-	-	-	Keep	No action alternative continued as required by SCS-Corps.
Floodplain evacuation (5-year floodplain)	No	No	No	No	No	No	No	Drop	Severe loss of agricultural production.
Tax incentives for conservation practices	-	-	-	-	-	-	-	Drop	A legislative task impractical to cover in this study.
Reestablish undisturbed shoreline and streambank vegetation to provide filtration of runoff	-	-	-	-	-	-	-	Drop	Considered in the land treatment alternative. Minnesota Soil and Water Conservation Board has had a demonstration program.
More equitable distribution of benefits and costs	-	-	-	-	-	-	-	Drop	Assessment of benefits is prescribed by State law.
Increase waterbank program	-	-	-	-	-	-	-	Drop	A current national program exists; the level of program funding is determined by legislative action.
Flood insurance	-	-	-	-	-	-	-	Drop	A national flood insurance program exists. Recommendations for flood insurance will be included under the floodplain zoning alternative.
Flood benefit tax	-	-	-	-	-	-	-	Drop	A legislative task impractical to cover in this study.
Cooperation with other States to determine costs and benefits	-	-	-	-	-	-	-	Drop	This is normal procedure. Coordination with Minnesota and South Dakota is accomplished through their representation on study work groups, contacts in the offices of the governors, and participation in citizen participation meetings.

(1) Acceptability for continued study only within the limitations and constraints of individual agencies as noted in this report or expressed in correspondence of Appendix C (e.g., letters from Governors of Minnesota and South Dakota, U.S. Fish and Wildlife Service). The citizens participation committee response was received through an evaluation/screening meeting. All alternatives are subject to review by agencies and groups during further study and prior to implementation in accordance with the planning requirements of the Water Resources Council Principles and Standards.

(2) These alternatives will be reviewed for acceptability on a case by case basis by the agencies.

DESCRIPTION AND EVALUATION OF ALTERNATIVES

No Action

This alternative does not provide major physical improvements or new programs by any level of government to reduce recurrent flood damages. The National Flood Insurance Program would continue to be available for participation. The Area II, Minnesota River Basin Projects, Inc. would continue as local sponsor for the State grant-in-aid program for building floodwater retarding and retention structures in the study area. Flooding would continue with an average annual flood damage loss of about $13.4 million for the future without project base condition for the year 2000, as shown in the following table. This loss would decrease with the expansion of the State grant-in-aid program. No attempts were made to determine the reduction in damages as a result of this State grant-in-aid program. The future without condition assumes some land use changes and increases in yields as a result of improved technology and management techniques adopted by farmers.

Average Annual Damages by Subbasin - Future Without Project Condition

Subbasin	Average Annual Area Flooded (acres)	Crop Damage	Other Ag. Damage	Soil Damage	Trans. Damage	Indirect Damage	Total Damage
Lac qui Parle	71,916	$2,175,852	$265,938	$435,170	$503,412	$319,691	$3,700,063
Cottonwood	31,204	1,769,725	107,941	353,945	218,428	220,531	2,670,570
Redwood	32,788	1,277,620	148,115	255,524	229,516	177,001	2,087,776
Yellow Medicine	65,194	2,736,835	304,419	547,367	456,358	372,579	4,417,558
Yellow Bank	6,700	286,994	30,287	57,399	46,900	38,763	460,343
Total	207,802	8,247,026	856,700	1,649,405	1,454,614	1,128,565	13,336,310

Land Treatment

Three sets of projections were developed to address the land treatment alternative. These initial projections were based on general data and will be refined as the study progresses. The first two projections illustrate the number of acres of the different land uses that will require treatment to increase protection to 70 and 80 percent, respectively, over the entire study area. The present level of protection, which varies by land use, ranges from 53 percent for pasture/range to 71 percent for other land(1) and averages 59 percent for all land uses. The third projection addresses only the total watershed area above all potential reservoir sites which amounts to about 35 percent of the total study area. The present protection of about 51 percent on this acreage is projected to 70 percent.

Alternative 1 would require protection of an additional 240,000 acres of cropland, 40,000 acres of pasture/range, and 2,500 acres of woodland to attain 70-percent overall protection. This would decrease annual soil erosion by 920,000 tons resulting in an overall 11-percent reduction from present conditions. This would require an additional 170 man-years of technical assistance plus an average installation cost of about $48 per acre for a total planning and installation cost of $17.7 million.

Alternative 2 would require protection of an additonal 455,000 acres of cropland, 65,000 acres of pasture/range, 8,000 acres of woodland, and 12,000 acres of other land to attain 80-percent overall protection. This would decrease annual soil erosion by 1,750,000 tons or by 21 percent. This alternative would require an additional 325 man-years of technical assistance plus installation costs of about $51 per acre for a total planning and installation cost of $35.6 million.

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(1) Other land is acreage of non-Federal rural land not classified as cropland, pasture, range or woodland. This includes farmsteads, farm roads, feed lots, fence rows, wildlife land, and rural nonfarm land.

Alternative 3 would require protection of an additional 109,000 acres of cropland, 42,000 acres of pasture/range, and 650 acres of woodland to attain 70-percent protection for the watershed area above all potential reservoir sites. This would decrease annual soil erosion by 470,000 tons or 15 percent on the area involved. This would require an additional 90 man-years of technical assistance plus installation costs of about $46 per acre for a total planning and installation cost of $9.2 million.

STUDIES FOR CHANNEL ALTERNATIVES

General

A major problem in the study area is the lack of channel capacity in that flat area between the base of the Coteau and the entrenched lower channel reaches. Man's activities have interfered with the natural development of the drainage system. Channels are restricted by development of the transportation systems including diversion of high flows, restricted channel crossings, and lack of a maintenance program. A pertinent section of chapter 105, Minnesota Statutes, states:

> "105.475 STREAM MAINTENANCE PROGRAM. Subdivision 1. Findings. In recognition of recurrent problems created by debris and rubble accumulation in streams in Minnesota, the legislature finds that the removal of debris and rubble for the purpose of cleaning up stream beds and flood plains of streams is of benefit to the public health, safety, and welfare."

Studies of alternative plans for flood damage reduction will include an evaluation of the feasibility of various channel measures. Channel measures may include structural works such as channel enlargement, channel cutoffs, snagging and clearing, and leveed floodways. Studies will also provide the basic data necessary to make decisions on nonstructural measures such as the public purchase of floodplain land, environmental corridors, floodplain zoning, and floodplain evacuation. These studies will be in compliance

with Executive Orders 11988 and 11990. The basic tool to be used in these evaluations is the development of water surface profiles for a range of flood frequencies. The water surface profiles will establish: (a) the frequency at which flooding begins in a reach; (b) the area flooded for a range of flood frequencies including delineation of selected floods on maps and mosaics; (c) channel and floodplain velocities for use in determining reaches subject to streambank erosion, floodplain scour, or deposition; and (d) reaches with restricted flow due to channel size, excessive vegetation, sediment blocks, or undersized bridges.

Development of these data will allow evaluation of a selection of alternative structural and nonstructural measures in various stream reaches. For example, channel enlargement may be the first priority of study in reaches that have frequent flooding of cropland due to undersized channels. Reaches that have limited capacity due to excessive vegetation may be evaluated for snagging and clearing.

The delineation of floods on maps and photomosaics will allow identification of the types of land use affected by various frequency floods. This will assist in determination of benefits and environmental impacts of structural measures and in selection of reaches that may be best suited for environmental corridors or where other nonstructural measures may apply.

Following is a brief description of the channel alternatives that will be studied and planning considerations.

Channel Work. This alternative provides increased channel capacity by channel excavation. The benefits from the reduced frequency of flooding and reduced area flooded are weighed against the costs of the work and the environmental impacts.

Channels will be designed to remain stable. This usually involves channel alignment to prevent cutting on bends and grade stabilization structures to reduce velocity on excessive grades. Channel enlargement often involves the replacement or underpinning of bridges.

Channels must have an adequate outlet to receive the required flow without excessive scour or deposition.

Losses of fish and wildlife habitat may require mitigation. The ecological impacts of changing the flow characteristics of the stream will need to be determined.

In 1970 the Corps of Engineers prepared a Preliminary Report on Phase I Studies of the Yellow Medicine and Lac qui Parle Rivers. These studies included an evaluation of channel modification in certain reaches of the Yellow Medicine and Lac qui Parle Rivers. Following are excerpts from this preliminary report:

> Early reconnaissance of the study area indicated that the most practicable solution to the flood problem might be channel straightening and enlarging in the Yellow Medicine River watershed with some remedial work in the Lac qui Parle River basin to prevent overflows into the Spring Creek and Mud Creek subbasins. Following this reconnaissance, studies were made of channel improvements along the Yellow Medicine River and its tributaries - - North Fork Yellow Medicine River, Mud Creek, and Spring Creek; along the Lac qui Parle River and its tributary, West Fork Lac qui Parle River; and along Florida Creek, a tributary to the West Fork Lac qui Parle River. The estimated overall benefit-cost relation based on criteria as of July 1965 was 1.2.
>
> Further, more detailed channel analyses were made for reaches 1, 5, 6 and 7 during 1966 and 1967. Results indicated that these four reaches acting together and based on a 10-year frequency flood design would have a benefit-cost ratio of 1.2. However, improvements on the Lac qui Parle River basin reaches were found to be infeasible when considered independently. Channel improvements along Mud, Spring, and Florida Creeks (reaches 3, 4, and 8, respectively) were not evaluated in depth because these streams were considered to be within the jurisdiction of the Soil Conservation Service.

In 1970 a brief review was made to update the channel improvement designs to current conditions. The increase in interest rates and the use of normalized agricultural prices has the effect of increasing the costs while decreasing the benefits. This review shows that channel improvement on reach 1, the Yellow Medicine River, might be marginally economically feasible at best. Based on prior results, channel improvement on the other reaches would not be feasible.

The Corps of Engineers Phase I study cost data have been updated to 1979 costs for each of the four reaches studied in detail. Total damages and the reduction in damage due to channel modification have been reevaluated. The following two tables display the results of this evaluation. The reach numbers from the Corps 1967 study are shown on the following map. The reach numbers for the 639 study channel evaluation reaches are shown on the Lac qui Parle and Yellow Medicine Rivers Subbasin maps on pages 47 through 51 of this main report.

SUMMARY OF ALTERNATIVES EVALUATION

Lac Qui Parle and Yellow Medicine Subbasins

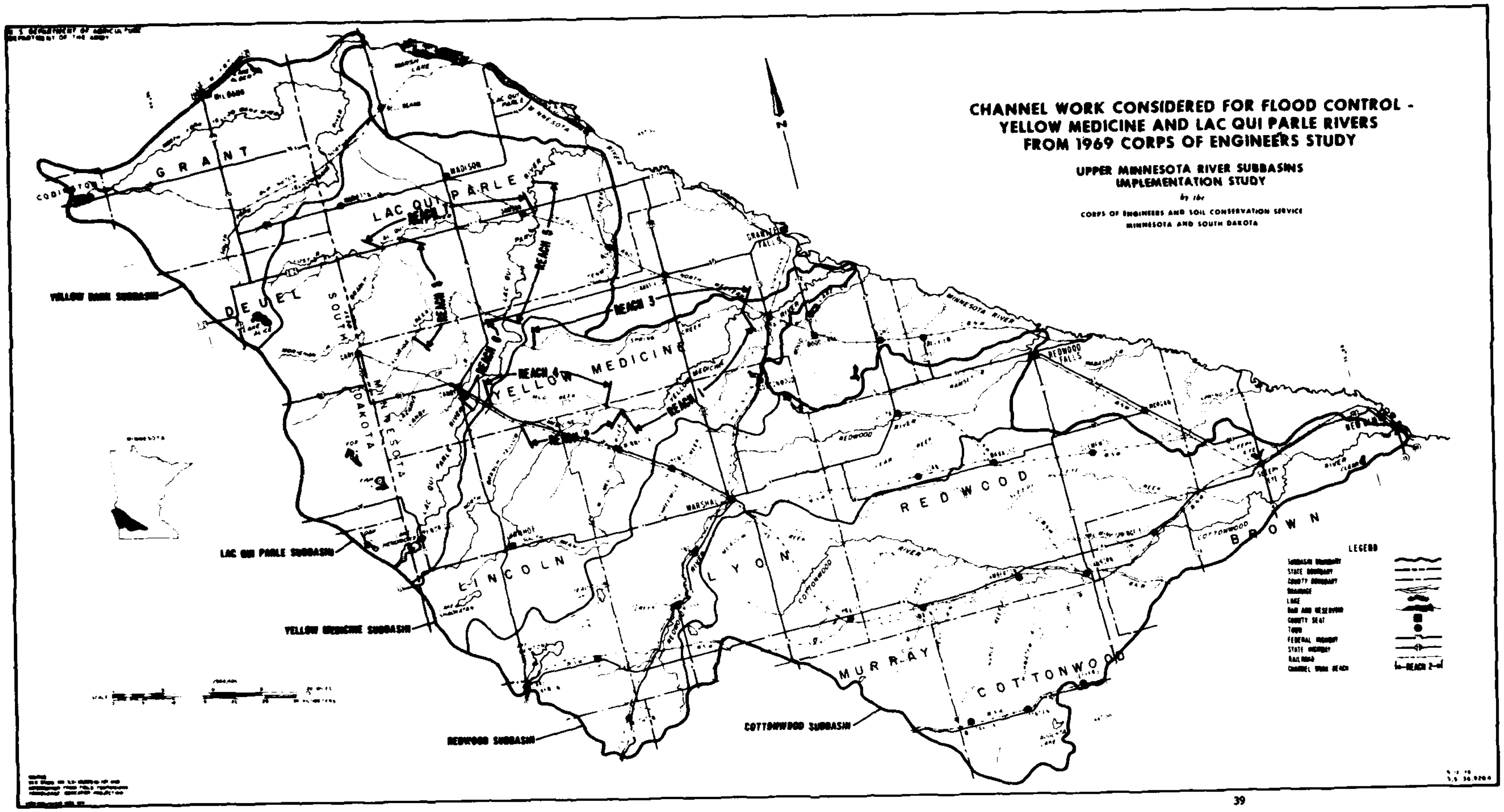
Flood Control Alternative Channel Reaches	Economic	Environmental			Social	Regional Development	Keep	Drop	Tentatively* Dropped
		Biological	Recreational	Cultural					
LQP-5	-1	-3 to -2	-3 to -2	-2	NA	+1		x	
LQP-6	+1	-2	-1	-2	NA	+1			x
LQP-7	-2	-2	-1	-3	NA			x	
YM-1	+1	-1 to -3	-2	-3	NA	+1			x

*These Alternative Components are dropped from further study until the Hydrology and Economic models are completed and noted conditions are satisfactorily resolved. At that time the components will be re-evaluated and a final screening made.

SUMMARY OF PERTINENT INFORMATION

Yellow Medicine and Lac Qui Parle Subbasins

Reach No. From Corps 1967 Study & Reach Location	Reach Nos. 639 Study	Distance	Average Depth	First Cost	Comments and Significant Impacts
		miles	feet	thousands	
-1- Yellow Medicine R. above confluence with Spring Cr. to confluence of North & South Br.	Y5003 Y5005 Y5006 L5001 L5002 TOTAL	34.9	8.0	8,280	The upper and lower end of reach is wooded. A state game refuge is located at the lower end of the reach.
-5- Main Lac Qui Parle River from below Dawson to Lazarus Creek	Q0702 Q0703 Q0704 Q0705 Q0706 TOTAL	35.6	8.5	7,288	Three wildlife management areas and a well wooded riparian area are along the reach.
-6- Lac Qui Parle River from confluence of Lazarus Cr. to Hwy 68.	Y0204C Y0204B Y0204A Y0203B Y0203A	20.9	8.5	4,393	A wildlife management area could be affected and there is existing riparian cover.
-7- West Branch Lac Qui Parle River to Hwy 212 upstream from Florida Cr.	Q1201 Q1202A Q1202B Q1205 Q1212 TOTAL	28.6	8.5	8,280	The stream is well wooded in the lower reaches.


CHANNEL WORK CONSIDERED FOR FLOOD CONTROL -
YELLOW MEDICINE AND LAC QUI PARLE RIVERS
FROM 1969 CORPS OF ENGINEERS STUDY
UPPER MINNESOTA RIVER SUBBASINS
IMPLEMENTATION STUDY
by the
CORPS OF ENGINEERS AND SOIL CONSERVATION SERVICE
MINNESOTA AND SOUTH DAKOTA
N
GRANT
LAC QUI PARLE
DEUEL
SOUTH DAKOTA
MINNESOTA
YELLOW MEDICINE
LINCOLN
LYON
REDWOOD
MURRAY
COTTONWOOD
BROWN
REACH 3
REACH 4
REACH 5
REACH 6
MADISON
MARSHALL
REDWOOD FALLS
MINNESOTA RIVER
YELLOW BANK SUBBASIN
LAC QUI PARLE SUBBASIN
YELLOW MEDICINE SUBBASIN
REDWOOD SUBBASIN
COTTONWOOD SUBBASIN
LEGEND
REACH 2

Following are the environmental concerns for channel work in general and for these reaches in the Yellow Medicine and Lac qui Parle Rivers.

Riparian woodlands; stream fisheries; Type 3, 4, 5 wetlands; public wildlife and recreation areas; and present or potential archeological and historic resources which would be adversely affected by channel work are the major environmental concerns in the basin regarding this alternative. Included in these concerns are the direct effects to the channel or stream corridor from construction and indirect effects such as improved drainage outlets for offsite wetland drainage and land use conversions of new flood free lands to more intensive uses.

The severity of impacts to the affected resources depends on the type and extent of channel work done. Channel excavation, widening, deepening, and straightening generally produce the most severe adverse impacts while setback levees, designated floodways, and corridors generally preserve present resource conditions or improve them for natural uses.

Each stream or channel is divided into reaches for evaluation. Further studies will provide impact information on each reach. The information then will be combined for each stream or channel and by subbasin.

Channel excavation of the Yellow Medicine River above the confluence with Spring Creek to the confluence of North and South Branches (reaches) would have very serious impacts to resources in the upper and lower segments and slight impacts in the middle segment.

Channel excavation of the Lac qui Parle River reach 5 would produce serious to very serious impacts to the environmental resources; reaches 6 and 7 would have serious impacts on these resources.

The tables on pages and of this report display the results of the evaluation of channel work in the Yellow Medicine and Lac qui Parle Rivers. A description of the rating factors can be found in the evaluation of the reservoir alternatives which follows.

Snagging and Clearing. This channel alternative emphasizes removal of obstructions and blockages in the present channel with minimal or no excavation. Excessive vegetation, log jams, or sediment blockages which cause backwater and flooding are removed from the channel and properly disposed of. Trees and other streambank vegetation are removed only in the stream channel. In some cases, vegetation is removed from only one side of the channel. Benefits from snagging and clearing are due to increased hydraulic efficiency which reduces the frequency and degree of flooding. Any loss of fish and wildlife habitat will be evaluated.

Channel Cutoffs. Channel cutoffs may be used to reduce flooding along a long reach of channel by diverting the flow through a shorter reach. They are often used to reduce the number of bridges required or for bridge alignment.

Care must be taken to design cutoff channels that will remain stable since the stream grade is increased. Peak flows may be increased downstream from a cutoff and induced damages may result. Damages may also be shifted from one location to another.

Cutoffs can be harmful to fish and wildlife by reducing or eliminating the low flow from the reach that has been cut off. It is often possible to design a cutoff with suitable control at the new channel so that low flows are maintained in the old channel.

Leveed Floodways. Leveed floodways can be used to carry water through an area being flooded primarily from upstream drainage areas. The concept considered here is that the present channel or area of overland crossover flow would remain and levees would be constructed on both sides to contain the floodwaters of a specified frequency flood. In a crossover flood area, the most feasible path would be used for the leveed floodway.

Problems encountered are the need for side inlets to provide for local drainage to the side of the levees. By containing a flood within the

levees, flood stages may be higher for longer periods of time and side drainage may be impaired, requiring a longer period for water to drain. Problems are also encountered when the levees overtop and flooding occurs for a longer duration on adjacent land than under present conditions.

Crossover Levees. Crossover levees to prevent crossover flow of water into adjacent subbasins would be used in conjunction with other alternatives. This measure would cause higher flood stages downstream of the crossover area and downstream channel works may be required. The levees would be designed to prevent the 100-year frequency flood from "crossing over" into an adjacent subbasin.

Public Purchase of Floodplain Lands

Public purchase of land in the floodplain to protect existing natural areas and establish greenbelts would effect flood reduction and conform to principles of floodplain management. The purchasing program would assure public ownership of lands adjacent to the rivers. The total lands are about 86 percent cropland, 6 percent woodland, and 8 percent for other uses. The woodland is mostly along each side of the river in a scattered pattern, with cropland abutting the channel over a majority of the channel lengths. The purchase of these floodplain lands would have a minimal effect on flood levels or on flood damages. Preservation of these lands as natural areas or greenbelts would provide benefits as recreation corridors, fish and wildlife habitat, and scenic areas. An example of a reach of river with potential for public purchase of adjacent lands for flood control is Spring Creek in the subbasin where structural measures would cause severe economic and environmental impacts. However, the economic impact would not be as severe as floodplain purchase along the agricultural reaches of channel where the value of production foregone is generally in excess of flood damages experienced on the lands with the changed use.

Environmental Corridors. Environmental or conservation corridors can be used to protect and preserve important biological, recreational, scenic, or cultural resources which occur along rivers and streams or around lakes and

wetlands, while maintaining natural floodways and watercourses in low intensity uses to assure minimal damage from flooding. Corridors can be established using zoning, access easements, fee title purchases, and tax incentives singly or in combinations.

Corridors will be studied primarily as an alternative to channel work in the study area. Proposed channel reaches will be screened by the Environmental Work Group to determine those which would be seriously impacted by channel work and which lend themselves to corridor designation. Major items of consideration will include: present and projected flood damages along the reach, important fish and wildlife habitats, scenic and recreational or cultural resources which should be preserved, and the potential of a corridor to include those resources in an economically and socially acceptable manner. Corridors are ideally suited for trail development between major points of interest. Studies will therefore include consideration of corridors between State parks, historic sites, wildlife observation areas, and urban reaches, and to connect with other trails or corridors. Reaches proposed for corridors will be included in alternative plans during the remaining study period, and hydrologic studies of the effects of the corridors and other components of the alternative plans on downstream flooding will be conducted.

Floodplain-Zoning/Enforcement

This alternative is expected to be a major component of a coordinated local-State-Federal flood damage reduction program. Existing Federal and State policy stresses nonstructural measures such as floodplain zoning, flood proofing, and flood warning practices. Chapter 104 of the Minnesota Statutes Subb. 4 declares that floodplain management ordinances are to be given primary consideration in the reduction of flood damages and that alternative methods may not be carried out before adoption of floodplain management ordinances by local governmental units. Work on this alternative depends on completion of channel studies and delineation of the flood damaged area.

Floodplain Evacuation

Evacuation of the floodplain is a viable method of flood damage reduction along natural channel reaches or reaches with low agricultural productivity. The evacuation would include both changed land use compatible with flooding, such as pasture, and relocation of any structures out of the floodplain. The economic optimum of agricultural lands production evacuated versus damages prevented would determine elevation and width of the evacuation area with suitable value and benefits assigned to natural areas such as the Spring Creek situation described above. Evacuation of the floodplain would include floodplain regulations on future use of the lands to have the optimum effect on flood levels or on flood damages. The lands could remain in private ownership with the appropriate guarantees provided through floodplain regulations. This aspect of private versus public ownership and the probable greater expediency in public purchase over evacuation are the major differences between these two alternatives. Either of these alternatives coupled with floodplain zoning and enforcement is a significant action to round out a flood management program in situations where economic, environmental, social, or regional development impacts of other alternatives are too severe to counter with appropriate mitigation.

Flood Proofing

Flood proofing consists of a combination of structural changes and adjustments to properties subject to flooding for the purpose of reducing or eliminating flood damages. Although best applied to new construction, in certain instances it can be applied to existing facilities, particularly in rural areas where it is technically feasible to construct ring levees around farmsteads.

Because almost all of this land is already used for agriculture, an acceptable purpose for floodplain lands, this alternative would mainly involve flood proofing rural farmsteads in flood prone areas. If this plan were implemented, care would have to be taken to insure that flood proofed

farmsteads would not become isolated during major floods.

Restoration of Wetlands

This is an alternative way of providing water retention and storage areas for floodwaters, wildlife habitat, water quality improvement, sediment reduction and other purposes. It can be used instead of or in conjunction with reservoirs and other structural or nonstructural alternatives to provide temporary or permanent retention and storage of water. Included in this alternative are several possible measures. Present wetlands of low quality due to insufficient water can be improved by providing additional water to the present areas. Water levels can be raised by providing better outlet control structures. Dry or drained wetland basins can be restored to their former water levels by constructing dikes, providing outlet control structures, or blocking outlet drains.

County resource inventory maps will be used to locate wetlands or former basins which could provide sufficient surface area to justify improvement or restoration. These sites will then be located on U.S. Geological Survey topographic maps and analyzed for water storage potential. Hydrologic studies of the effects on downstream flooding or peaks by restoring or modifying the wetland will be conducted as soon as the hydrologic modeling for the area is complete. Sites which provide cost effective floodwater storage will be included in alternative NED plans. Others may be carried forward as environmental measures. Although single purpose wetland developments for wildlife habitat improvement might be recommended, it is anticipated that the sites selected during studies of this alternative would be multipurpose wildlife-flood control developments. Those situations not within the authorities of the Corps and SCS will be identified for accomplishment by others such as the U.S. Fish and Wildlife Service or States of Minnesota and South Dakota.

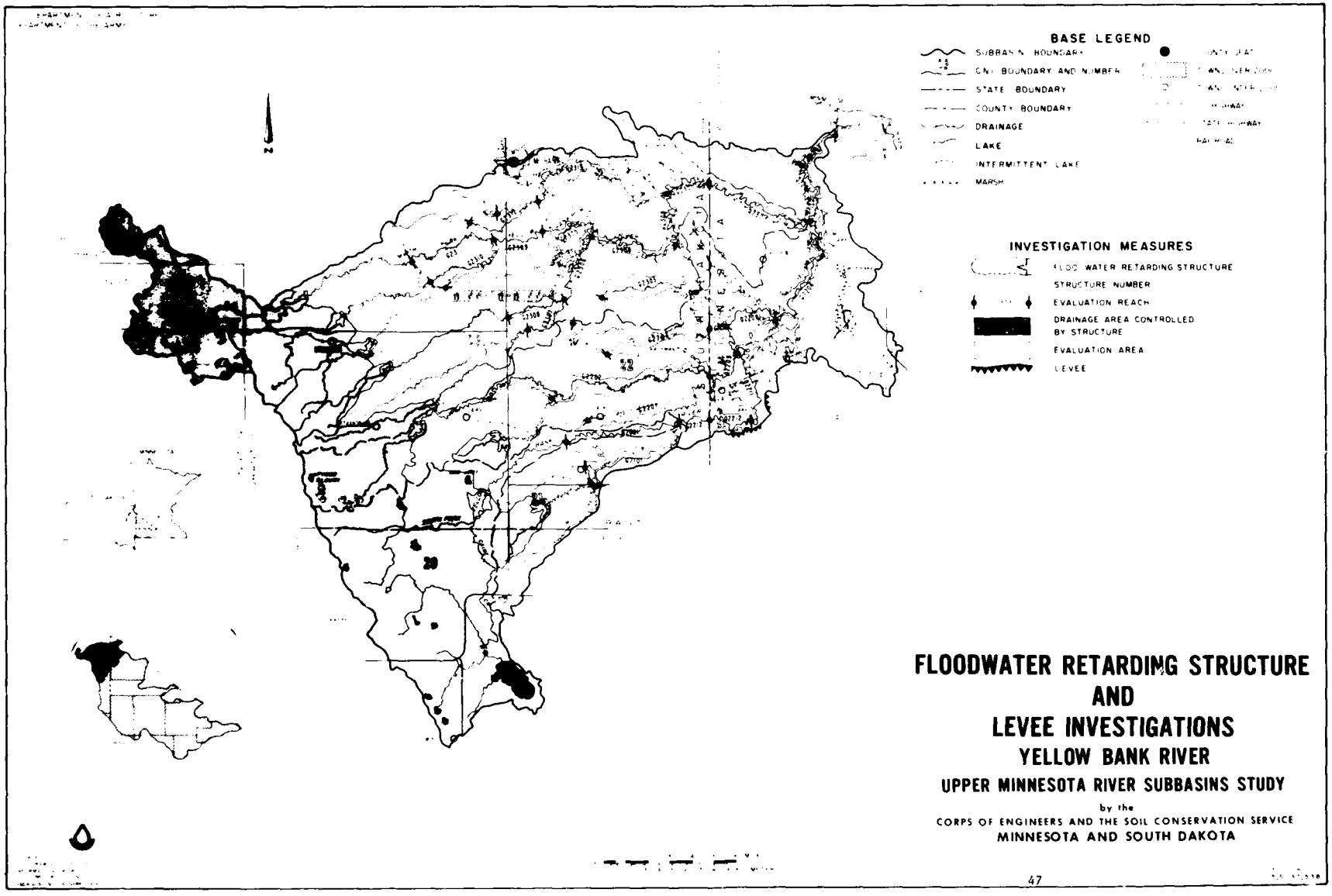
Floodwater Storage Reservoirs

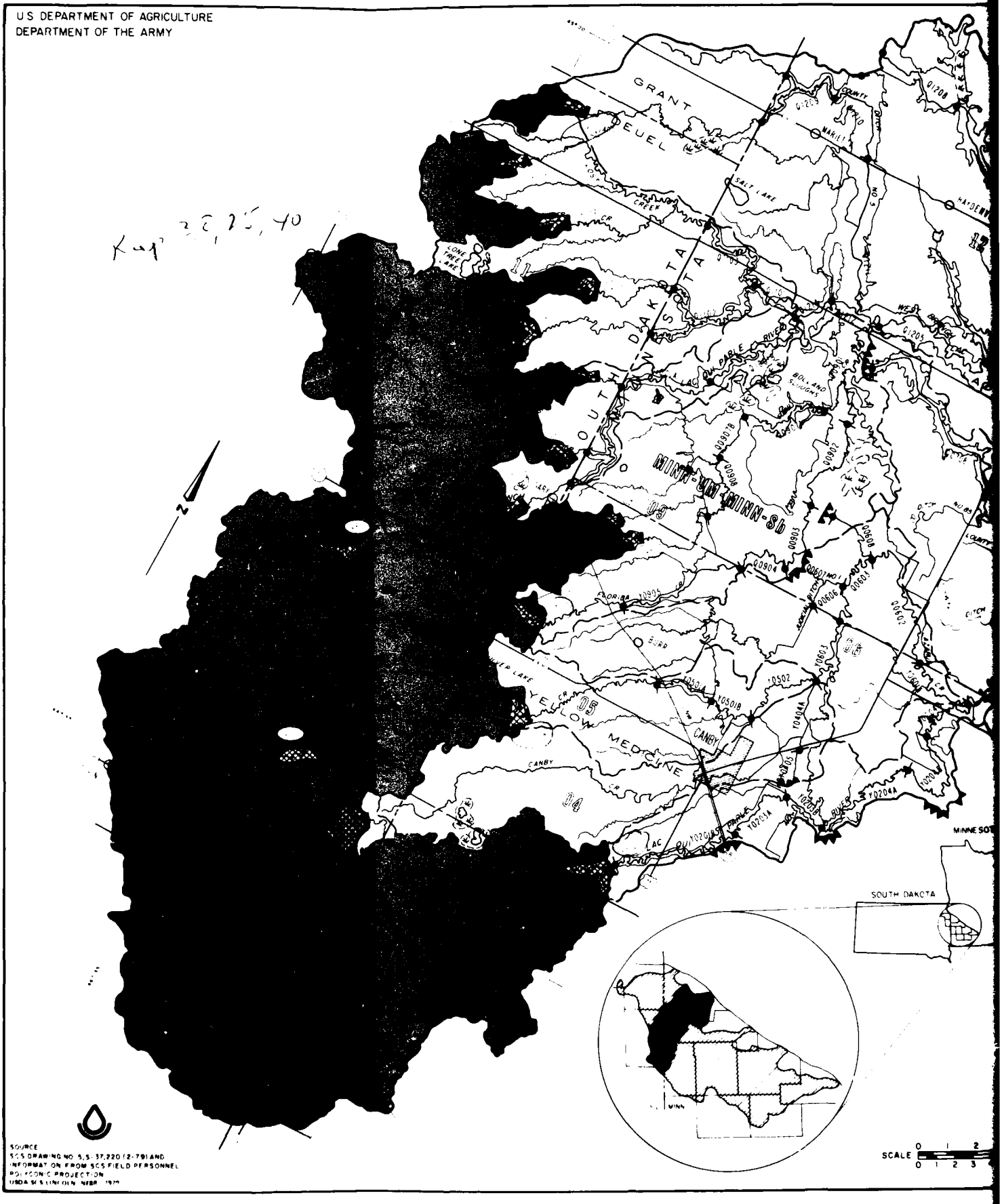
General

Floodwater retarding reservoirs for the five subbasins were evaluated to determine which structures should be considered for further study. An initial screening was made of the 81 reservoirs that were considered to be feasible in the SCS Type 4 Study. The Type 4 Study had considered 206 reservoirs. Eight structures with under 3 square miles drainage area were eliminated from further study. Another eight structures were eliminated due to lack of sufficient storage capacity. Some structures have already been constructed or are scheduled for construction. Following the initial screening, 65 reservoirs remained in the evaluation. Due to lack of data, upper structures in series could not be evaluated from an economic standpoint.

The reduction in flooding with the 65 retarding reservoirs in place was determined through use of the SCS TR-20 Hydrologic Model. A detailed description of the methodology can be found in the Hydrology and Hydraulics section of Appendix A. No attempt was made to optimize benefits by trying various combinations of retarding structures. The reduction in flooding was determined with all 65 structures in place and also assuming that levees would be constructed if necessary to prevent crossover flow between subbasins. The reduction in flooding due to an individual structure was then based on the ratio of the drainage area controlled by the structure to the drainage area controlled by all structures above the damage reaches. Evaluations were made in 153 damage reaches located primarily on the major floodplains.

The structure and levee locations and the evaluation reaches used to determine benefits are shown on the following maps for each subbasin.


BASE LEGEND
SUBBASIN BOUNDARY
C.N.T. BOUNDARY AND NUMBER
STATE BOUNDARY
COUNTY BOUNDARY
DRAINAGE
LAKE
INTERMITTENT LAKE
MARSH
INVESTIGATION MEASURES
FLOOD WATER RETARDING STRUCTURE
STRUCTURE NUMBER
EVALUATION REACH
DRAINAGE AREA CONTROLLED BY STRUCTURE
EVALUATION AREA
LEVEE
FLOODWATER RETARDING STRUCTURE AND LEVEE INVESTIGATIONS
YELLOW BANK RIVER
UPPER MINNESOTA RIVER SUBBASINS STUDY
by the
CORPS OF ENGINEERS AND THE SOIL CONSERVATION SERVICE
MINNESOTA AND SOUTH DAKOTA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SOURCE
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POLYCONIC PROJECTION
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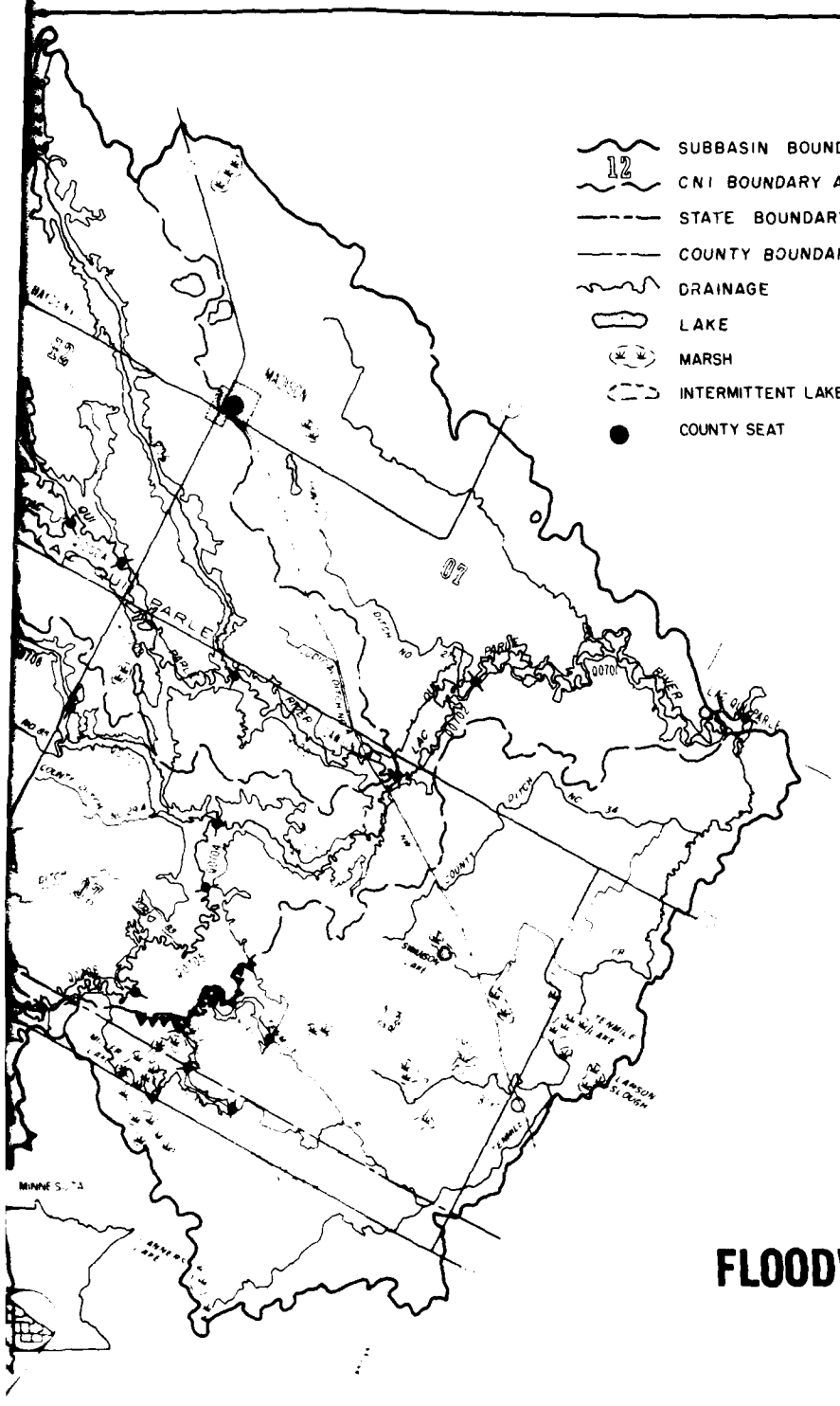

BASE LEGEND

- SUBBASIN BOUNDARY
- 12 — CNI BOUNDARY AND NUMBER
- STATE BOUNDARY
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- MARSH
- INTERMITTENT LAKE
- COUNTY SEAT
- TOWNS OVER 2000
- TOWNS UNDER 2000
- U.S HIGHWAY
- STATE HIGHWAY
- RAILROAD

INVESTIGATION MEASURES

- FLOODWATER RETARDING STRUCTURE
- STRUCTURE NUMBER
- Y0204A — EVALUATION REACH
- DRAINAGE AREA CONTROLLED BY STRUCTURE
- EVALUATION AREA
- LEVEE

FLOODWATER RETARDING STRUCTURE AND LEVEE INVESTIGATIONS

LAC QUI PARLE RIVER

UPPER MINNESOTA RIVER SUBBASINS STUDY

by the

CORPS OF ENGINEERS AND THE SOIL CONSERVATION SERVICE

MINNESOTA AND SOUTH DAKOTA

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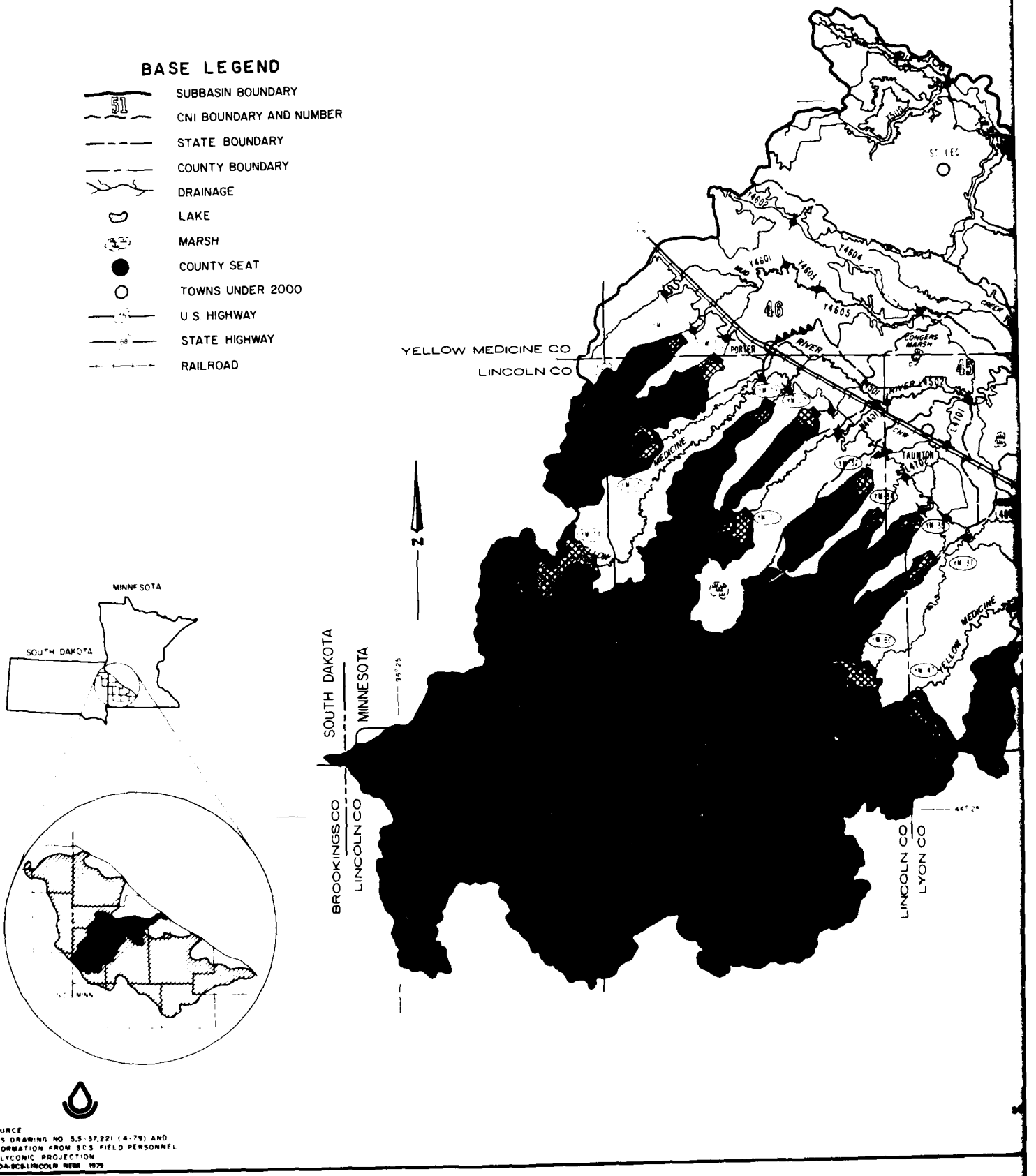
DEPARTMENT OF THE ARMY



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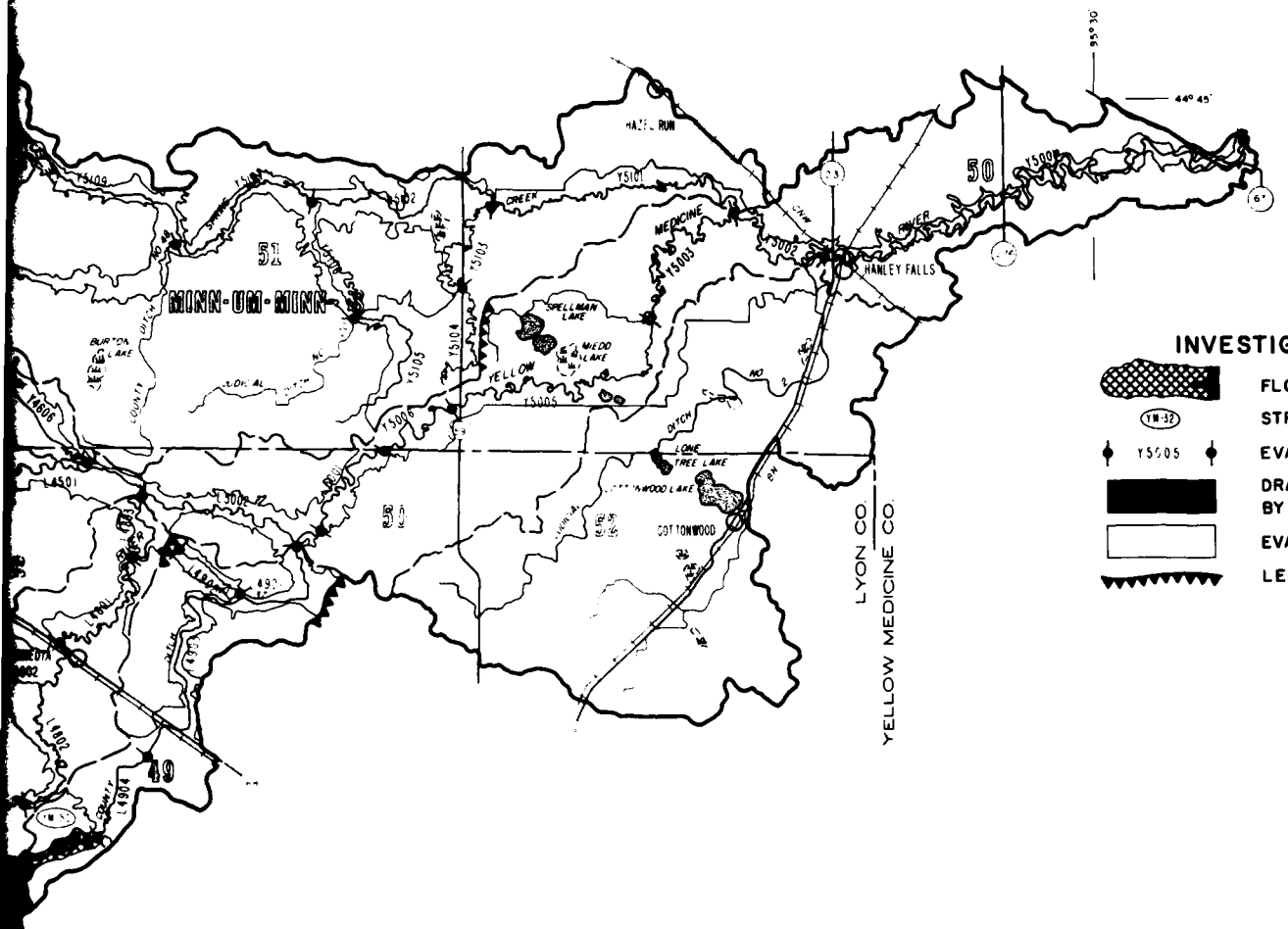

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LEVEE INVESTIGATIONS
YELLOW MEDICINE RIVER
UPPER MINNESOTA RIVER SUBBASINS

by the

CORPS OF ENGINEERS AND THE SOIL CONSERVATI

MINNESOTA AND SOUTH DAKOT

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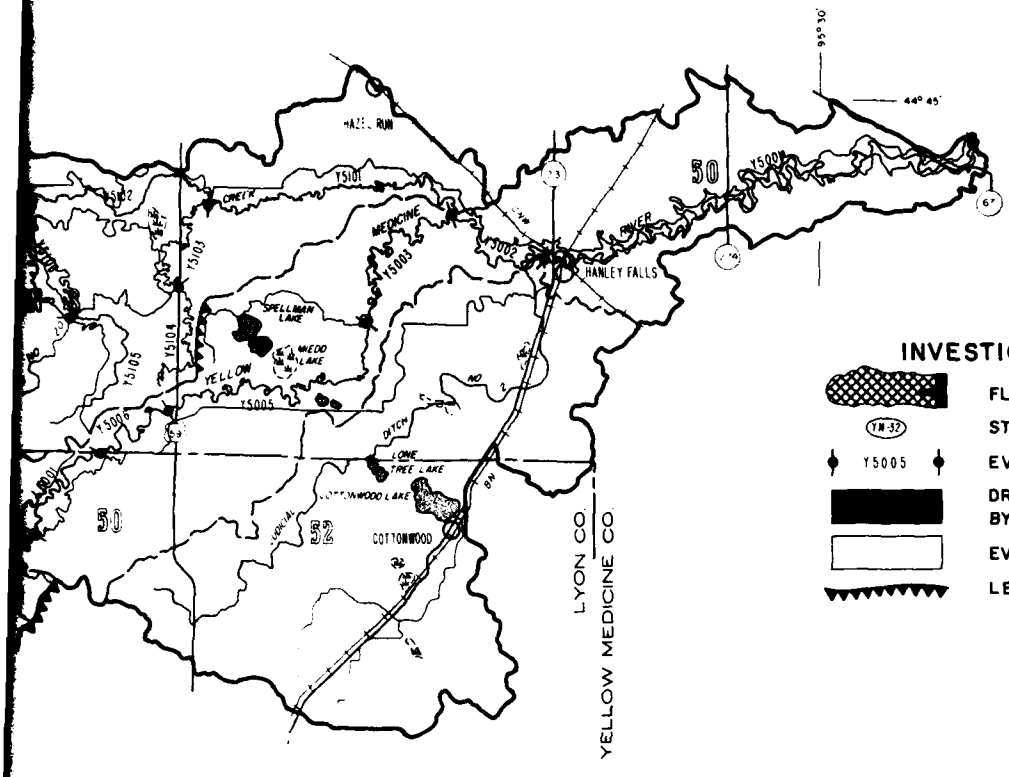

INVESTIGATION MEASURES

- FLOODWATER RETARDING STRUCTURE
- (YM-32) STRUCTURE NUMBER
- Y5005 EVALUATION REACH
- DRAINAGE AREA CONTROLLED BY STRUCTURE
- EVALUATION AREA
- LEVEE

FLOODWATER RETARDING STRUCTURE AND LEVEE INVESTIGATIONS

YELLOW MEDICINE RIVER

UPPER MINNESOTA RIVER SUBBASINS STUDY

by the

CORPS OF ENGINEERS AND THE SOIL CONSERVATION SERVICE

MINNESOTA AND SOUTH DAKOTA

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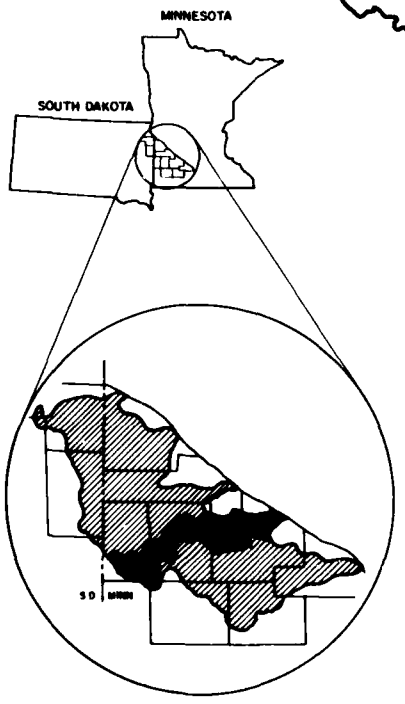
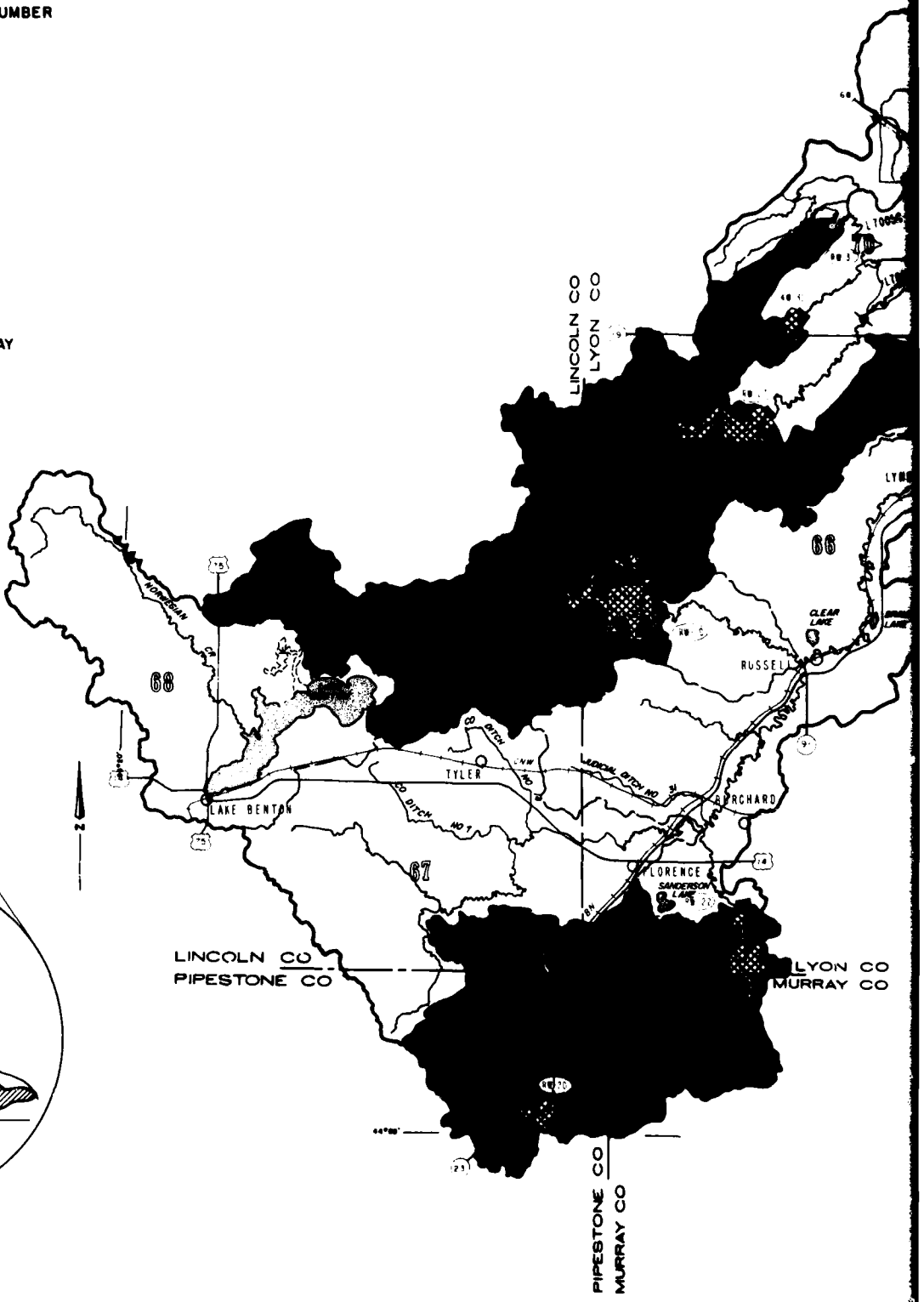
3

U.S. DEPARTMENT OF AGRICULTURE
DEPARTMENT OF THE ARMY

BASE LEGEND

- SUBBASIN BOUNDARY
- 66 CNI BOUNDARY AND NUMBER
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- MARSH
- COUNTY SEAT
- TOWNS OVER 2000
- TOWNS UNDER 2000
- U.S. HIGHWAY
- STATE HIGHWAY
- MULTILANE STATE HIGHWAY
- RAILROAD





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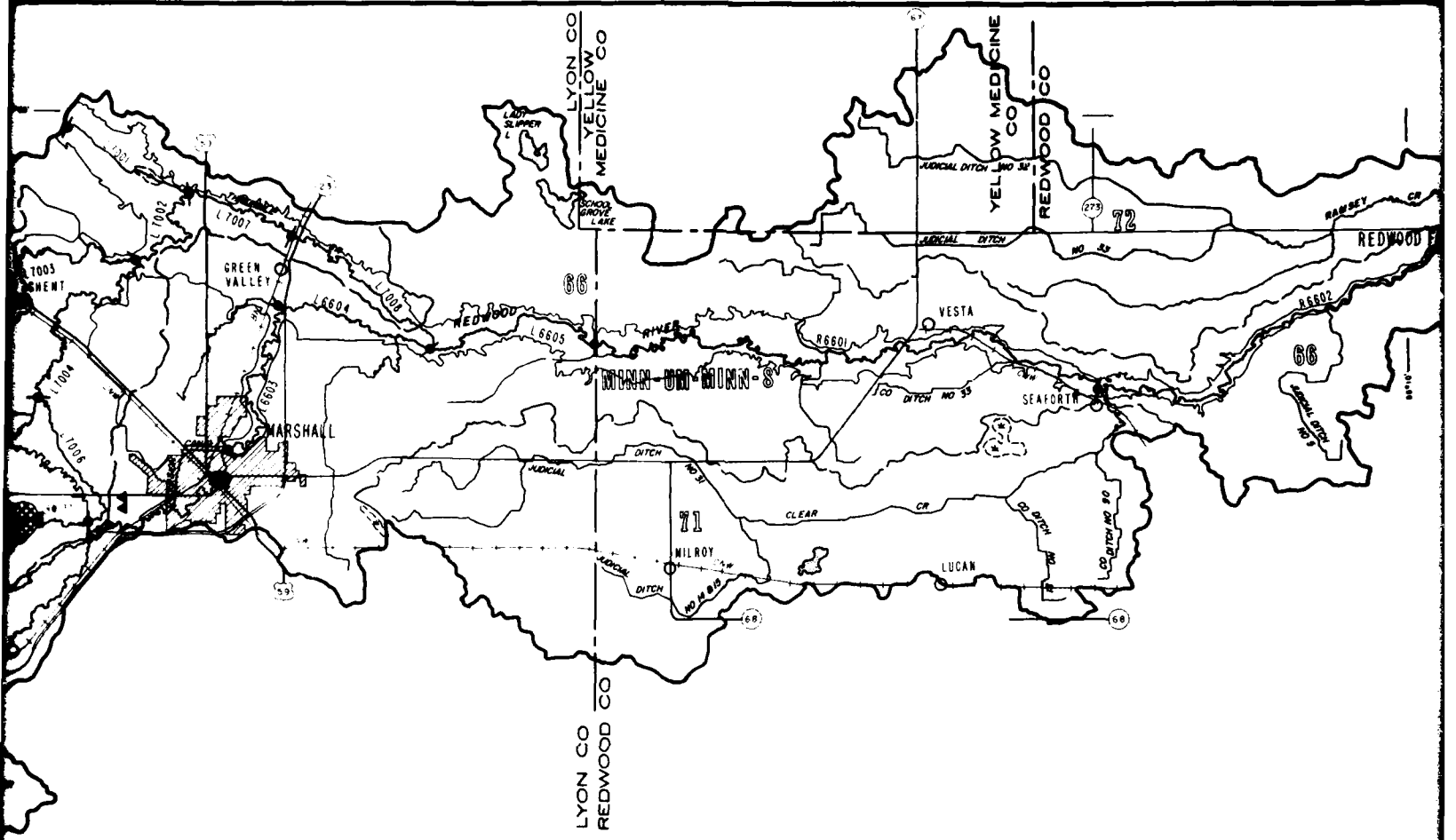
POLYCONIC PROJECTION
USDA-SCS-LINCOLN, NEBR. 1979



INVESTIGATION MEASURES

- FLOODWATER RETARDING STRUCTURE
- STRUCTURE NUMBER (RW 37)
- EVALUATION REACH (L1005C)
- DRAINAGE AREA CONTROLLED BY STRUCTURE
- EVALUATION AREA
- LEVEE

FLOODWATER RETARDI
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UPPER MINNESOTA RIVER S

by the

CORPS OF ENGINEERS AND THE SOIL
MINNESOTA

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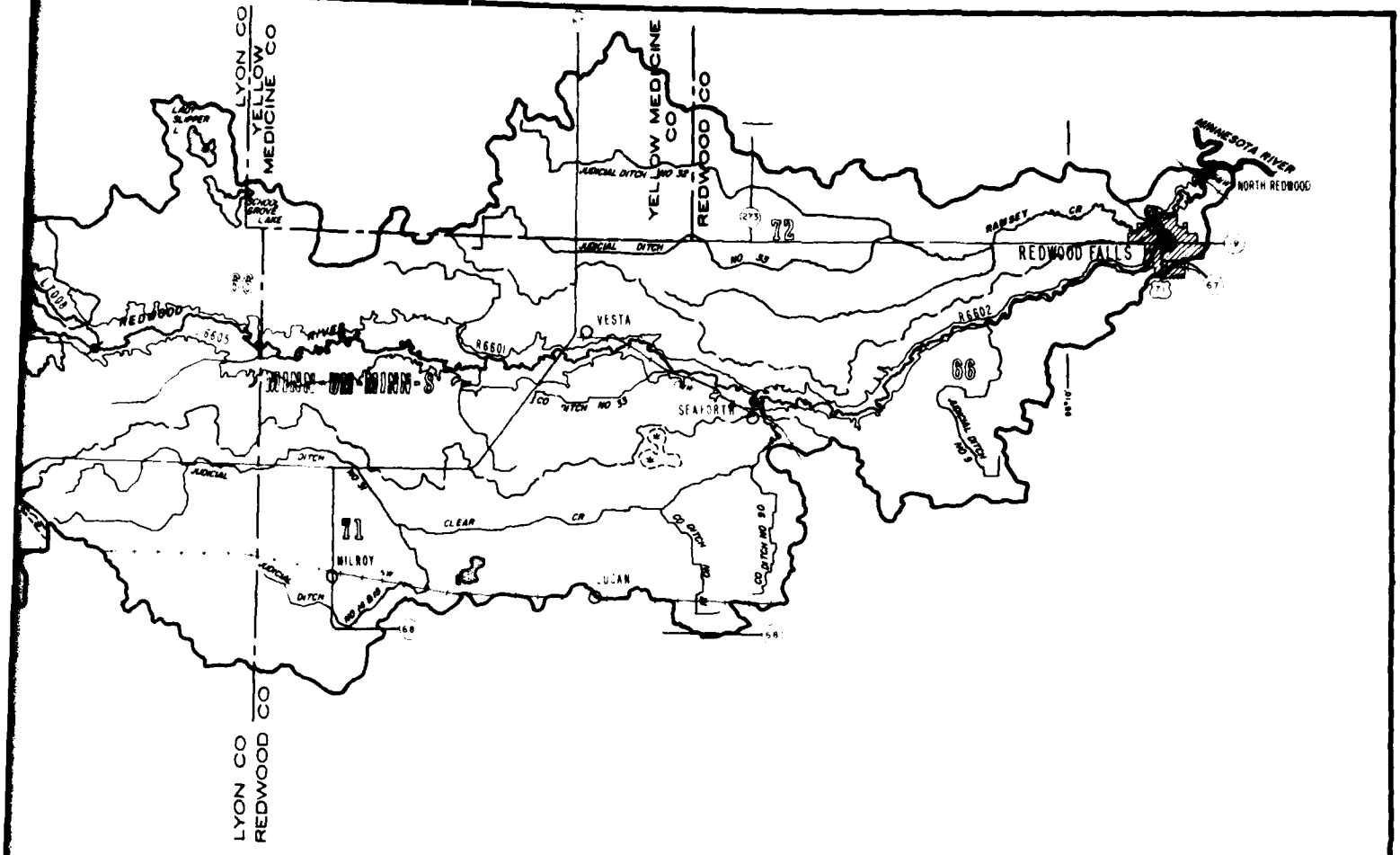

VESTIGATION MEASURES

- FLOODWATER RETARDING STRUCTURE
- STRUCTURE NUMBER
- EVALUATION REACH
- DRAINAGE AREA CONTROLLED BY STRUCTURE
- EVALUATION AREA
- LEVEE

FLOODWATER RETARDING STRUCTURE AND LEVEE INVESTIGATIONS

REDWOOD RIVER

UPPER MINNESOTA RIVER SUBBASINS STUDY

by the

CORPS OF ENGINEERS AND THE SOIL CONSERVATION SERVICE

MINNESOTA

5 MILES
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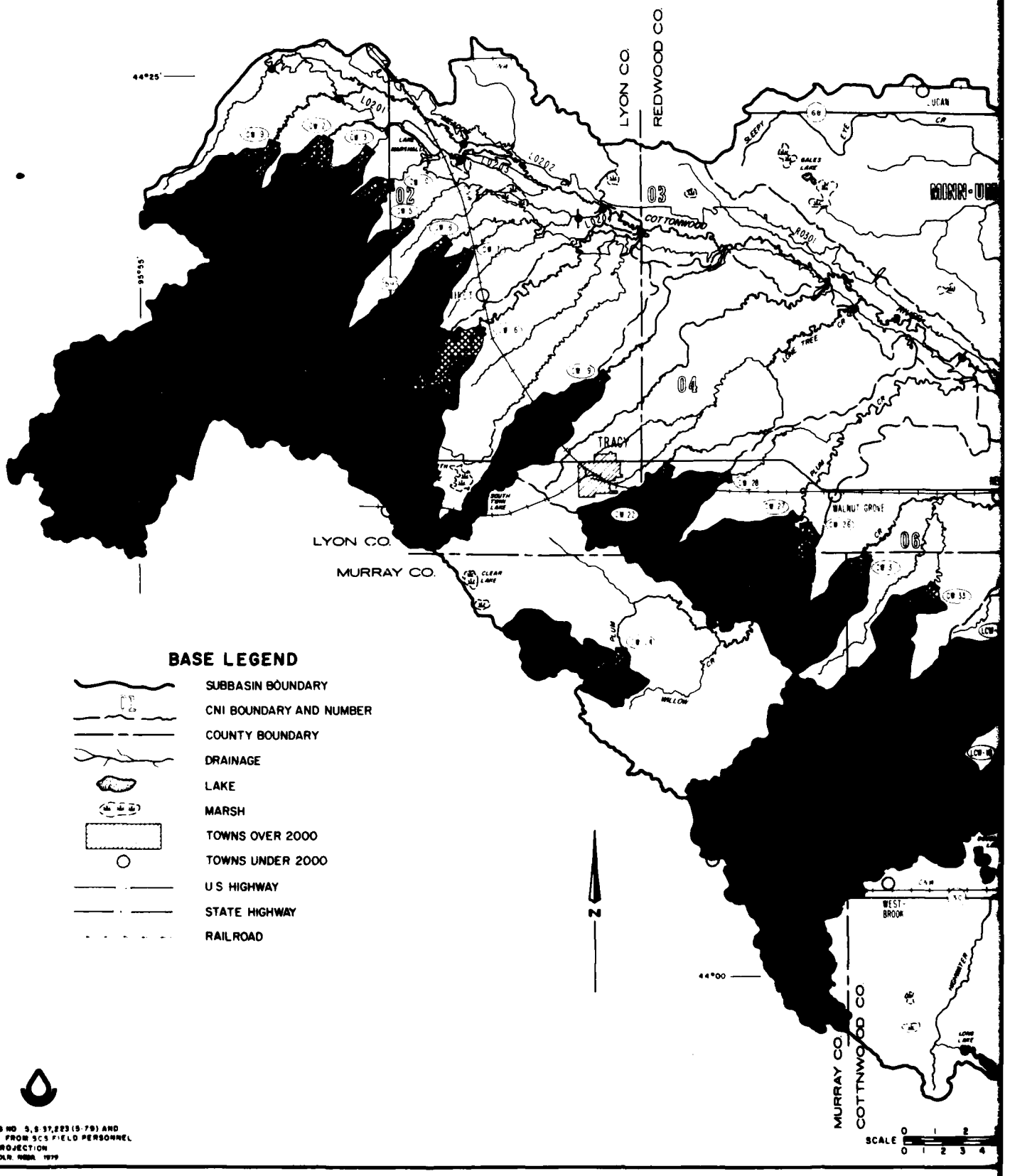
U.S. DEPARTMENT OF AGRICULTURE
DEPARTMENT OF THE ARMY



BASE LEGEND

- SUBBASIN BOUNDARY
- CNI BOUNDARY AND NUMBER
- COUNTY BOUNDARY
- DRAINAGE
- LAKE
- MARSH
- TOWNS OVER 2000
- TOWNS UNDER 2000
- U S HIGHWAY
- STATE HIGHWAY
- RAILROAD

SOURCE
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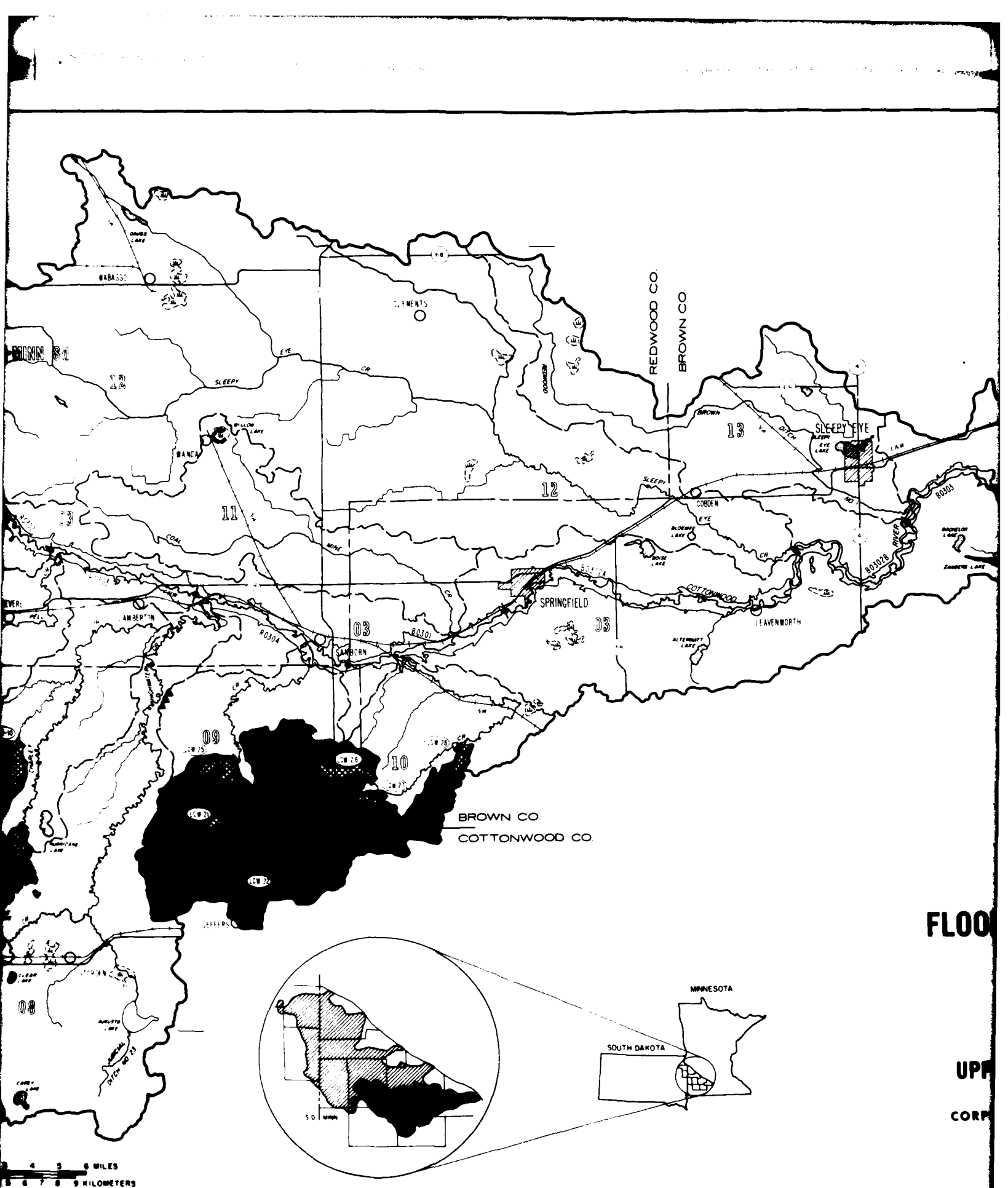

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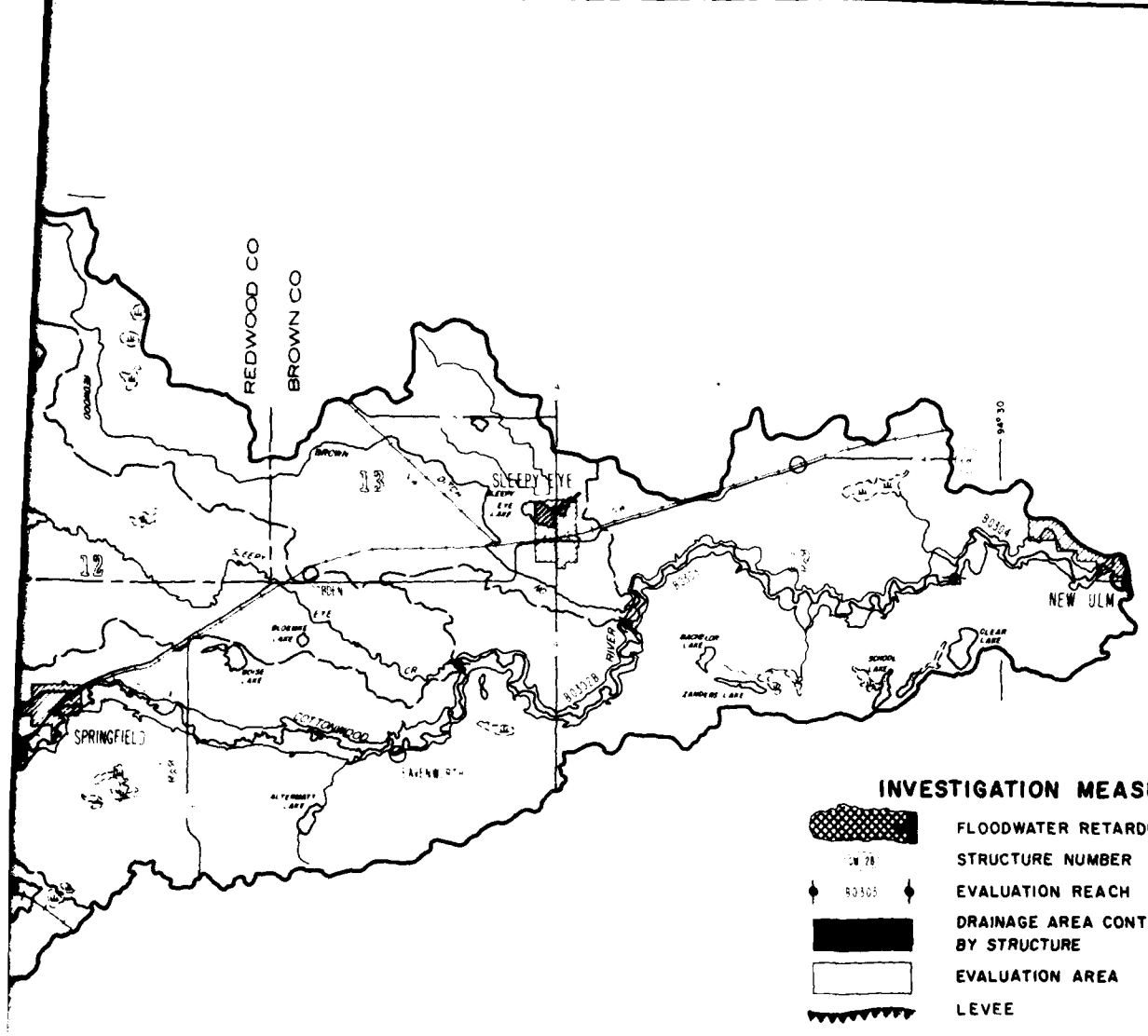

INVESTIGATION MEASURES

- FLOODWATER RETARDING STRUCTURE
- STRUCTURE NUMBER
- EVALUATION REACH
- DRAINAGE AREA CONTROLLED BY STRUCTURE
- EVALUATION AREA
- LEVEE

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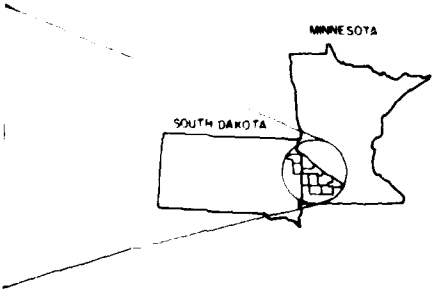


FLOODWATER RETARDING STRUCTURE AND LEVEE INVESTIGATIONS

COTTONWOOD RIVER

UPPER MINNESOTA RIVER SUBBASINS STUDY

by the

CORPS OF ENGINEERS AND THE SOIL CONSERVATION SERVICE

MINNESOTA

9-13-79
S,R-37,542

The evaluation of the retarding reservoirs, as shown in the following tables, includes the economic evaluation; an evaluation of the impact on the biological, recreational and cultural resources; and the impact on social life and regional development.

The evaluation is displayed by a rating system ranging from -3 to +3. Following is a brief description of the ratings for each concern. Detailed descriptions of the considerations for ratings can be found in Appendix A.

Economic ratings: Benefits allocated to individual structures were weighed against the estimated costs of the structures. Each structure was then rated from -3 to +3 depending on the benefit-cost ratio.

Environmental ratings were based on preliminary data for each reservoir site. These ratings are site specific and do not include positive or negative impacts upstream or downstream of the site.

Biological ratings of +1, +2, +3 indicate reservoirs which would destroy habitat in excess supply (cropland), or are poor quality (overgrazed pasture) and which would provide benefits of wetlands or a deep lake fishery. Ratings of -1, -2, -3 indicate destruction of critically short habitats (deer wintering areas) or high quality habitats which are not offset by the pool benefits.

Recreation ratings of -1, -2, -3 reflect losses of hunting or fishing opportunities due to habitat losses, or losses of present park or other recreation resources with no offsetting benefits from construction of the reservoir. Ratings of +1, +2, +3 indicate sites which could increase hunting, fishing, or other recreation opportunities and which have little or no negative impacts on present recreation resources.

Social effects related to reservoirs were analyzed only for the reservoir site, thus are mostly negative. That is, people close to the site will experience the burden of relocation, construction noise, disruption of roads and utilities, and loss of property. Ratings of -1, -2, -3 indicate

the severity of these site specific impacts to the landowners and the immediate area. Severe ratings indicate sites which would cause several relocations, are opposed by most of the owners, inundate major roads, disrupt utilities, or other social considerations; the most severe ratings indicate that several of these impacts occur at the same site.

Cultural ratings were assigned values from 0 to -3 as none of the reservoirs possess qualities beneficial to cultural resources. A rating of -3 indicates that archeological or historic sites have been recorded or reported within or close to the reservoir site and the potential is great that additional unrecorded sites exist in the area. A -2 rating indicates that no cultural sites are presently known to exist in the area but the potential for finding sites in the area, based on the limited information available, is believed to be slight or unknown.

In all environmental ratings, a -3 rating should be viewed as a screening tool used to identify those sites which would cause major, adverse, nearly unmitigable impacts to presently known resources and which, early in the study process, should be avoided entirely, if at all possible.

Regional development refers to the increased income generated in the area influenced by the project. This includes Federal money brought into the area for project construction which will create new jobs for local residents.

With a higher level of flood protection, farmers will increase production which will increase other economic activities directly and indirectly related to services rendered to the farming sector. For those reasons all structures were assumed to have a positive effect on regional development.

Environmental Concerns

Yellow Bank - The major concerns in this subbasin are State-designated high priority stream fisheries, high quality riparian woodlands which are known deer wintering areas, high quality native grasslands, and present or poten-

tial recreational, archeological, and historic resources which would be adversely affected by reservoir construction. YB-3 and YB-15 would result in the most serious impacts to these resources, while YB-5 and YB-11 would have impacts slightly less severe. YB-18 could provide some wetland development benefits.

Lac qui Parle - High quality riparian woodlands which are known deer wintering areas; high quality native grasslands or ungrazed pastures; Type 3, 4, 5 wetlands; and present or potential recreational, archeological, and historic resources are the major environmental concerns in this subbasin. Construction of LQP-5, LQP-8 and LQP-28 would result in the most serious impacts to these resources. LQP-3, LQP-26, and LQP-34 would have slightly less severe impacts. With properly designed sediment pools, many of the remaining sites could provide some wetland development benefits. LQP-4 is physically ideal for development of extensive wetlands. If constructed it could provide major wetland benefits.

Yellow Medicine - High quality riparian woodlands which are known deer wintering areas; high quality native grasslands or ungrazed pastures; Type 3, 4, 5 wetlands; and present or potential recreational, archeological, and historic resources are the major environmental concerns in this subbasin. Construction of YM-47 would result in the most serious impacts to these resources, while YM-25 and YM-37 would have impacts slightly less severe. YM-24, YM-27, and YM-35 could provide wetland development benefits.

Redwood - High quality riparian woodlands which are known deer wintering areas; high quality native grasslands or ungrazed pastures; Type 3, 4, 5 wetlands; and present or potential recreational, archeological, and historic resources are the major environmental concerns in this subbasin. Public and private wetlands would be seriously impacted by the construction of RW-10 and RW-22. High quality native prairie or ungrazed pasture would be affected by RW-30. Present and potential archeological and historic resources would be seriously affected at these sites as well. RW-20 and RW-31 could provide wetland developments. RW-27 could physically provide a large deep lake if properly designed and if sufficient water is provided.

Cottonwood - High quality woodlands which are known deer wintering areas or which represent some of the last large blocks of forest land in the county; high quality native prairies or ungrazed pastures; Type 3, 4, 5 wetlands; and present or potential recreational, archeological and historic resources are the major environmental concerns in this subbasin. The most serious impacts to these resources would result with construction of CW-16, CW-26, LCW-18 and LCW-27. Slightly less severe impacts would result with construction of CW-2, CW-5, CW-10, CW-22 and CW-24. CW-6, CW-31, and LCW-10 could have wetland development benefits.

SUMMARY OF ALTERNATIVES EVALUATION

Yellow Bank Subbasin

Flood Control Alternative Reservoir Sites	Economic	Environmental			Social	Regional Development	Keep	Drop	Tentatively* Dropped
		Biological	Recreational	Cultural					
YB-3	-2	-3	-3	-2	-2	+1		X	
YB-5	-1	-2	-2	-2	-2	+1			X
YB-6	-1	-1	-1	0	-1	+1	X		
YB-8	+1	0	+1	0	-2	+1	X		
YB-11	+1	-2	0	-1	-1	+1			X
YB-15	+1	-3	-3	-3	-3	+1			X
YB-18	+3	+1	+1	0	-1	+1	X		
YB-25	+3	0	0	-1	-2	+1	X		
YB-30	-2	0	0	0	-1	+1			X

*These Alternative Components are dropped from further study until the Hydrology and Economic models are completed and noted conditions are satisfactorily resolved. At that time the components will be re-evaluated and a final screening made.

SUMMARY OF PERTINENT INFORMATION

Yellow Bank River Subbasin

SITE	Drain. Area Above Site	First Cost	Dam Height	Flood Pool (ES Crest)			Sediment Pool	COMMENTS/Significant Impacts
Reservoirs	Sq. Mi.	Thousands$	Feet	Acres	Ac.ft.	Inches	Acres	
YB-3	29.5	4,441	78	87	1390	0.9	30	Lake storage upstream of reservoir
YB-5	13.9	1,118	73	83	1919	2.6	18	
YB-6	8.0	617	68	63	1147	2.7	11	
YB-8	3.6	599	51	42	496	2.6	9	
YB-11	5.74	1,263	59	51	918	3.0	12	
YB-15	67.2	11,133	95	404	8225	2.3	60	
YB-18	4.3	430	50	49	726	2.9	14	
YB-25	13.0	567	54	98	1659	2.4	19	
YB 30	2.6	659	37	55	400	2.9	11	

SUMMARY OF ALTERNATIVES EVALUATION — Lac qui Parle Subbasin

Flood Control Alternative Reservoir Sites	Economic	Environmental			Social	Regional Development	Keep	Drop	Tentatively* Dropped
		Biological	Recreational	Cultural					
(1) LQP 2	-	+1	0	0	-2	+1			
LQP 3	+3	-2	-1	-2	-2	+1	X		
(2) LQP 4	-	+2	+1	-2	-2	+1		X	
(3) LQP 5	-	-3	-1	-2	-3	+1		X	
LQP 7	UPSTREAM	STRUCTURE IN	PLACE					X	
LQP 8	+2	-3	-1	-1	-3	+1	X		
(3) LQP 10	-	-1	+1	-2	-2	+1			
LQP 12	-1	+1	0	-	-1	+1			X
LQP 13	-2	+1	0	-	-1	+1			X
(4) LQP 25	+2	+1	+1	-2	-2	+1	X		
LQP 26	-3	-2	-1	-	-1	+1		X	
LQP 28	+1	-3	-2	-2	-2	+1			X
LQP 29	-2	+1	0	-	-1	+1			X
LQP 30	-1	-1	0	-	-1	+1			X

*These Alternative Components are dropped from further study until the Hydrology and Economic models are completed and noted conditions are satisfactorily resolved. At that time the components will be re-evaluated and a final screening made.

(1) LQP 2 is upstream of LQP 3 and all benefits were assigned to LQP 3.

(2) LQP 4 dropped for insufficient actual storage.

(3) Sites LQP 5 and 10 are upstream of LQP 8 and benefits were assigned to LQP 8.

(4) LQP 25 currently under study as a RC & D project.

SUMMARY OF ALTERNATIVES EVALUATION

Lac qui Parle Subbasin

Flood Control Alternative Reservoir Sites	Economic	Environmental			Social	Regional Development	Keep	Drop	Tentatively* Dropped
		Biological	Recreational	Cultural					
LQP 32	-2	+1	+1	-	-1	+1			X
LQP 34	-2	-2	+1	-	-1	+1		X	
LQP 38	-2	+1	+1	-	-1	+1			X
LQP 40	+3	+1	0	-	-1	+1	X		

*These Alternative Components are dropped from further study until the Hydrology and Economic models are completed and noted conditions are satisfactorily resolved. At that time the components will be re-evaluated and a final screening made.

SUMMARY OF PERTINENT INFORMATION

Lac Qui Parle River Subbasin

SITE	Drain. Area Above Site	First Cost	Dam Height	Flood Pool (ES Crest)			Sediment Pool	COMMENTS/Significant Impacts
Reservoirs	Sq. Mi.	Thousands	Feet	Acres	Ac. ft.	Inches	Acres	
LQP-2	15	535	49	137	2197	2.7	34	
LQP-3	50	5,712	95	235	6600	2.5	45	
LQP-4	294	10,440	28	1025	4700	0.3	450	Site lacks sufficient storage
LQP-5	72	3,622	25	1030	9400	2.4	730	Local opposition to raising lake levels
LQP-7	2.8	NA	58	40	560	3.7	-	Upstream structure in place
LQP-8	186	9,909	80	255	5800	0.6	70	
LQP-10	23.8	113	10	-	-	-	-	To be constructed as diversion levee
LQP-12	4.	591	35	64	685	2.7	18	
LQP-13	2.7	451	34	56	401	2.8	13	
LQP-25	25.2	-	72	160	2700	2.0	-	Possible RC & D project
LQP-26	30	1,089	85	97	3000	-	17	
LQP-28	14.1	896	72	82	1877	2.5	7	
LQP-29	2.4	380	47	22	327	2.5	6	
LQP-30	10.8	1,067	71	70	1591	2.8	18	
LQP-32	6.0	696	34	75	790	2.5	17	
LQP-34	6.4	666	56	52	943	2.8	13	
LQP-38	5.3	938	65	48	842	3.0	8	
LQP-40	2.8	326	41	30	418	2.8	12	

SUMMARY OF ALTERNATIVES EVALUATION Yellow Medicine Subbasin

Flood Control Alternative Reservoir Sites	Economic	Environmental			Social	Regional Development	Keep	Drop	Tentatively* Dropped
		Biological	Recreational	Cultural					
YM-21	-1	0	+1	0	-3	+1		X	
YM-23	In place by others								
YM-24	+2	+1	0	0	-2	+1	X		
YM-25	+3	-2	0	-1	-2	+1	X		
YM-27	-1	+2	0	0	-2	+1			X
YM-30	Construction scheduled 1980 by others.								
YM-31	+3	0	0	0	-1	+1	X		
YM-32	+1	-1	0	-1	-2	+1			X
YM-34	+2	-1	+1	0	-1	+1	X		
YM-35	+2	+1	0	0	-2	+1	X		
YM-37	+2	-2	-1	-1	-1	+1	X		
YM-47	+2	-3	-3	-2	-3	+1	X		
YM-50	Construction scheduled 1981 by others.								
YM-60	Construction scheduled 1979 by others.								

*These Alternative Components are dropped from further study until the Hydrology and Economic models are completed and noted conditions are satisfactorily resolved. At that time the components will be re-evaluated and a final screening made.

SUMMARY OF ALTERNATIVES EVALUATION

Redwood Subbasin

Flood Control Alternative Reservoir Sites	Economic	Environmental			Social	Regional Development	Keep	Drop	Tentatively* Dropped
		Biological	Recreational	Cultural					
RW-10	+1	-3	-2	-3	-3	+1			X
RW-17	-3	-	-	-	-	-		X	
RW-20	NA	+1	0	-3	-2	+1			X
RW-22	-2	-3	-2	-1	-3	+1		X	
RW-27	+2	+1	0	-1	-2	+1	X		
RW-30	+2	-1	0	-2	-2	+1	X		
RW-31	+3	+1	0	-1	-2	+1	X		
RW-37	+3	+2	0	0	-2	+1	X		

*These Alternative Components are dropped from further study until the Hydrology and Economic models are completed and noted conditions are satisfactorily resolved. At that time the components will be re-evaluated and a final screening made.

SUMMARY OF PERTINENT INFORMATION

Redwood River Subbasin

SITE	Drain. Area Above Site	First Cost	Dam Height	Flood Pool (ES Crest)			Sediment Pool	COMMENTS/Significant Impacts
Reservoirs	Sq. Mi.	Thousands$	Feet	Acres	Ac.ft.	Inches	Acres	
RW-10	44	4,876	29	675	7,000	3.0	150	
RW-17	6.6	--	-	-	-	-	-	Being built or planned by others
RW-20	2.9	355	31	52	451	2.9	15	Upstream of RW-22
RW-22	50	5,143	32	840	8,400	3.2	190	
RW-27	27	4,038	60	250	4,400	3.0	30	
RW-30	3.2	631	40	47	529	3.1	15	
RW_31	4.0	868	33	76	703	3.3	24	
RW-37	9.1	1,448	33	156	1,558	3.2	52	

SUMMARY OF ALTERNATIVES EVALUATION

Cottonwood Subbasin

Flood Control Alternative Reservoir Sites	Economic	Environmental			Social	Regional Development	Keep	Drop	Tentatively* Dropped
		Biological	Recreational	Cultural					
CW-2	+3	-2	0	-1	-1	+1	X		
CW-3	+3	-1	0	-2	-1	+1	X		
CW-5	+3	-2	-1	-2	-2	+1	X		
CW-6	+2	+1	0	0	-1	+1	X		
CW-7	+2	0	0	-1	-1	+1	X		
CW-9	+3	0	0	-1	-1	+1	X		
CW-10	+3	-2	-1	-2	-1	+1	X		
CW-16	-2	-3	-1	-3	-3	+1		X	
CW-19	+1	0	0	0	-1	+1	X		
CW-22	-2	0	-2	-3	-1	+1		X	
CW-27	In place by others.								
CW-28	-2	-1	0	-2	-1	+1		X	
CW-24	-2	-2	-1	NA	-2	+1		X	
CW-26	-2	-3	-3	-3	-2	+1		X	

*These Alternative Components are dropped from further study until the Hydrology and Economic models are completed and noted conditions are satisfactorily resolved. At that time the components will be re-evaluated and a final screening made.

SUMMARY OF ALTERNATIVES EVALUATION

Cottonwood Subbasin

Flood Control Alternative Reservoir Sites	Economic	Environmental			Social	Regional Development	Keep	Drop	Tentatively* Dropped
		Biological	Recreational	Cultural					
CW-31	-3	+1	0	-1	-2	+1		X	
CW-33	-3	0	0	-1	-2	+1		X	
Lower Cottonwood									
LCW-10	-1	+1	0	-1	-2	+1			X
LCW-18	-2	-3	-3	NA	-3	+1		X	
LCW-25	-1	0	0	NA	-3	+1			X
LCW-26	+3	-1	+1	NA	-2	+1	X		
LCW-27	-1	-3	+2	NA	-2	+1			X
LCW-28	-2	+1	0	NA	-1	+1			X
LCW-21 (1)		0	+1	NA	-2	+1			
LCW-22 (1)		-1	0	NA	-1	+1			

***These Alternative Components are dropped from further study until the Hydrology and Economic models are completed and noted conditions are satisfactorily resolved. At that time the components will be re-evaluated and a final screening made.**

(1) CW 21 and 22 are upstream of CW 25 and benefits were assigned to CW 25.

SUMMARY OF PERTINENT INFORMATION

Cottonwood River Subbasin

SITE	Drain. Area Above Site	First Cost	Dam Height	Flood Pool (ES Crest)		Sediment Pool		COMMENTS/Significant Impacts
Reservoirs	Sq. Mi.	Thousands $	Feet	Acres	Ac.ft.	Inches	Acres	
CW-2	6.1	638	38	79	1,037	3.2	25	
CW-3	2.5	412	30	40	422	3.2	16	
CW-5	5.3	606	48	52	806	2.8	17	
CW-6	3.1	626	35	57	528	3.2	15	
CW-7	4.0	950	40	61	708	3.3	17	
CW-9	7.5	707	44	92	1,224	3.1	29	
CW-10	6.0	905	39	79	963	3.0	29	
CW-16	48	9,732	69	390	7,700	3.0	65	
CW-19	7.1	725	47	75	1,187	3.2	30	
CW-22	3.8	776	41	54	667	3.3	16	
CW-24	6.1	578	17	356	856	2.6	19	
CW-26	61	5,956	58	222	3,000	0.9	68	
CW-27	7.0	-	-	-	-	-	-	Small structure already built
CW-28	4.5	736	40	82	837	3.6	22	
CW-31	4.7	901	37	85	926	3.7	26	
CW-33	5.5	867	39	102	1,012	3.4	24	

SUMMARY OF PERTINENT INFORMATION

Cottonwood River Subbasin

SITE	Drain. Area Above Site	First Cost	Dam Height	Flood Pool (ES Crest)			Sediment Pool	COMMENTS/Significant Impacts
Reservoirs	Sq. Mi.	Thousands $	Feet	Acres	Ac.ft.	Inches	Acres	
LCW-10	10.6	845	36	158	1,843	3.3	54	
LCW-18	42	5,441	62	90	6,200	2.4	65	
LCW-21	2.9	451	41	39	501	3.3	13	
LCW-22	3.2	557	41	49	604	3.5	14	
LCW-25	20.3	758	46	315	3,902	3.6	89	
LCW-26	13.7	1,531	23	411	2,591	3.5	131	
LCW-27	13.3	2,355	52	141	2,582	3.6	51	
LCW-28	3.7	763	34	72	731	3.5	19	

GENERAL EVALUATION OF FLOODWATER STORAGE RESERVOIRS BY SUBBASIN

Yellow Bank Subbasin - Nine structures were evaluated. YB-3 was found not feasible early in the study as most of the drainage area is controlled by Punished Woman Lake. Structure YB-15 controls 67 square miles and although feasibility is marginal, this site is considered necessary if crossover flow to the LQP subbasin is to be prevented.

No benefits were evaluated in the reaches immediately below the reservoir sites for this report.

Lac qui Parle Subbasin - Thirteen structures were evaluated. Structure sites LQP 2, 10 and 5 are upstream sites in series with other sites.

LQP-2 is the upstream site in series with LQP-3. For this evaluation of flood reduction, it was assumed that structure LQP-3 could be designed with a storage-release rate combination that would provide the required flood protection without structure LQP-2 in place. Further studies are required to verify this assumption. If structure LQP-3 does not have sufficient storage capacity, LQP-2 may be needed.

LQP-10 is a diversion which diverts 23 square miles from LQP-3 to LQP-8 through LQP-5. For this study, LQP-10 was assumed in place. There appears to be local opposition to any rise in Fish Lake above LQP-5. Therefore, LQP-5 was dropped from further study.

It may be feasible to install LQP-10 and divert water through Fish Lake without raising the permanent water level.

Yellow Medicine Subbasin - Ten structures were evaluated. Structure YM-23 was included in the model and allocated benefits even though it is already constructed.

Redwood Subbasin - Eight structures were evaluated.

Structure RW-20 is in series upstream from RW-22. Structures on the main stem and tributaries of the Redwood River above Marshall do not appear feasible. Structures upstream from Three Mile Creek appear feasible.

Cottonwood Subbasin - Twenty-four structures were evaluated. Benefits were assigned to CW-27 which is presently in place. Structures protecting upstream reaches appear feasible. Structures protecting downstream reaches appear to be not feasible with the exception of those on Mound Creek.

A summary of reservoir evaluations is shown in the following table. Because the hydrology-hydraulics data used in this screening are preliminary, reevaluation of some structures (channel reaches also) may be in order when the hydrologic-hydraulic model and related economics are completed in stage II.

Reservoir Alternatives Screening Summary

Large Reservoir Sites (D.A. Greater than 20 Sq. Mi.)

Subbasin	Keep	Tent. Drop[1]	Drop	Others[2]
	(Reservoir Site Number in Subbasin, See Maps Pages 38-42)			
Yellow Bank	-	15	3	-
Lac qui Parle	3,8	-	4,5,26	10,25
Yellow Medicine	24,47	-	21	-
Redwood	27	-	10,22	-
Cottonwood	-	-	16,18,26[3]	-
	5	1	10	2

Small Reservoir Sites (D.A. 20 Sq. Mi. and Smaller)

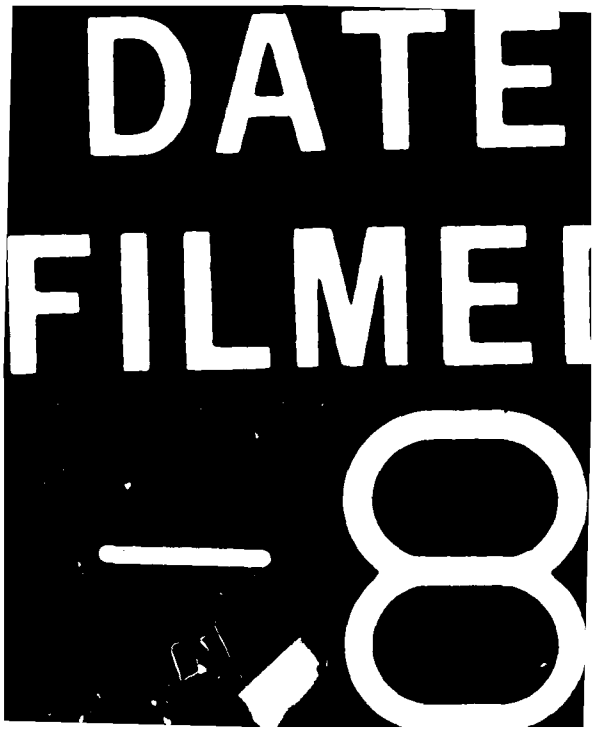
Subbasin	Keep	Tent. Drop	Drop	Others
Yellow Bank	6,8,18,25	5,11,30	-	-
Lac qui Parle	40	12,13,28,29,30 32,38	2,7,34	-
Yellow Medicine	25,31,34,35,37	27,32	-	23,30,50,60
Redwood	30,31,37	20	-	17
Cottonwood	2,3,5,6,7,9,10 19,26[3]	10[3],25[3],27[3], 28[3],21[3],22[3]	22,31,28 24,33	27
	22	19	8	6

Totals By Subbasins	Keep	Tent. Drop	Drop	Others
(9) Yellow Bank	4	4	1	-
(18) Lac qui Parle	3	7	6	2
(14) Yellow Medicine	7	2	1	4
(8) Redwood	4	1	2	1
(24) Cottonwood	9	6	8	1
73	27	20	18	8

1/ These alternatives are dropped from further study until the Hydrology and Economic Models are completed and noted conditions are satisfactorily resolved. The alternatives will then be reevaluated and a final screening made.

2/ LQP-10: Diversion levee
LQP-25: Possible RC & D project
YM-23: In place by others
YM-30: 1980 Construction planned by others
YM-50: 1981 Construction planned by others
YM-60: 1979 Construction planned by others
RW-17: Dropped because of insufficient storage
CW-27: In place by others

3/ Lower Cottonwood River Sites.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